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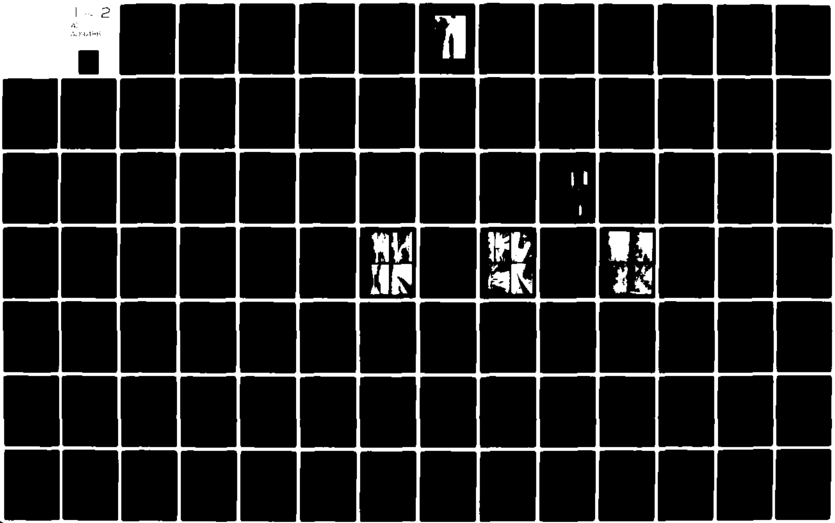

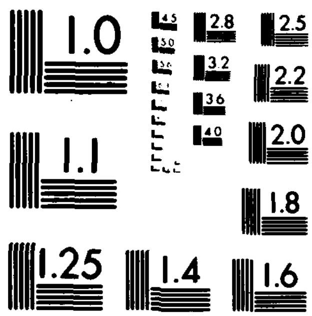

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TOTEM DAM

(NDI I.D. ~~No.~~ Number PA-00042,
PENNDER I.D. ~~No.~~ Number 8-8),

Susquehanna River Basin, Camps Creek,
Bradford County, Pennsylvania.

~~DACW31-80-C-0016~~

PHASE I INSPECTION REPORT,
NATIONAL DAM INSPECTION PROGRAM

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(10) Bernard M./Mihalcin

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DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topograhic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ABSTRACT

Totem Dam: NDI I.D. No. PA-00042

Owner: Colin M. Townsend

State Located: Pennsylvania (PennDER I.D. No. 8-8)

County Located: Bradford

Stream: Camps Creek

Inspection Date: 24 April 1980

Inspection Team: GAI Consultants, Inc.
570 Beatty Road
Monroeville, Pennsylvania 15146

Based on a visual inspection, operational history, and hydrologic and hydraulic analysis, the dam is considered to be in fair condition.

The size classification of the facility is small and its hazard classification is considered to be high. In accordance with the recommended guidelines, the Spillway Design Flood (SDF) for the facility ranges between the 1/2-PMF (Probable Maximum Flood) and the PMF. Due to the high potential for damage to downstream structures and loss of life that could be associated with a sudden embankment breach, the SDF is considered to be the PMF. Results of the hydrologic and hydraulic analysis indicate the facility will pass and/or store only two percent of the PMF prior to embankment overtopping.

The embankment has, in fact, been overtopped at least three times in the past decade. However, due to its unusual configuration, damage has been limited to scouring of the embankment and downstream roadway. Breach analyses performed in this study indicate that there are conditions for floods of less than 1/2-PMF magnitude during which the embankment could possibly fail and result in an increased potential for damage and loss of life downstream. Thus, the spillway system is considered to be seriously inadequate and the facility unsafe, non-emergency.

It is recommended that the owner immediately:

a. Develop a formal emergency warning system for the notification of downstream residents in the event hazardous conditions develop. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

b. Have the facility evaluated by a registered professional engineer experienced in the hydraulics and hydrology of dams to further assess the adequacy of the spillway and take remedial measures deemed necessary to make the facility hydraulically adequate.

c. Repair concrete deterioration wherever necessary including along the crest and downstream spillway face.

d. Check the present operability of the outlet conduit control valve and initiate repairs, if necessary. In addition, the conduit should be operated on at least an annual basis and preventive maintenance performed concurrently.

e. Formalize manuals of operation and maintenance to ensure proper future care of the facility.

GAI Consultants, Inc.	Approved by:
Bernard M. Mihalcin, P.E.	JAMES W. PECK Colonel, Corps of Engineers District Engineer

COMMONWEALTH OF PENNSYLVANIA
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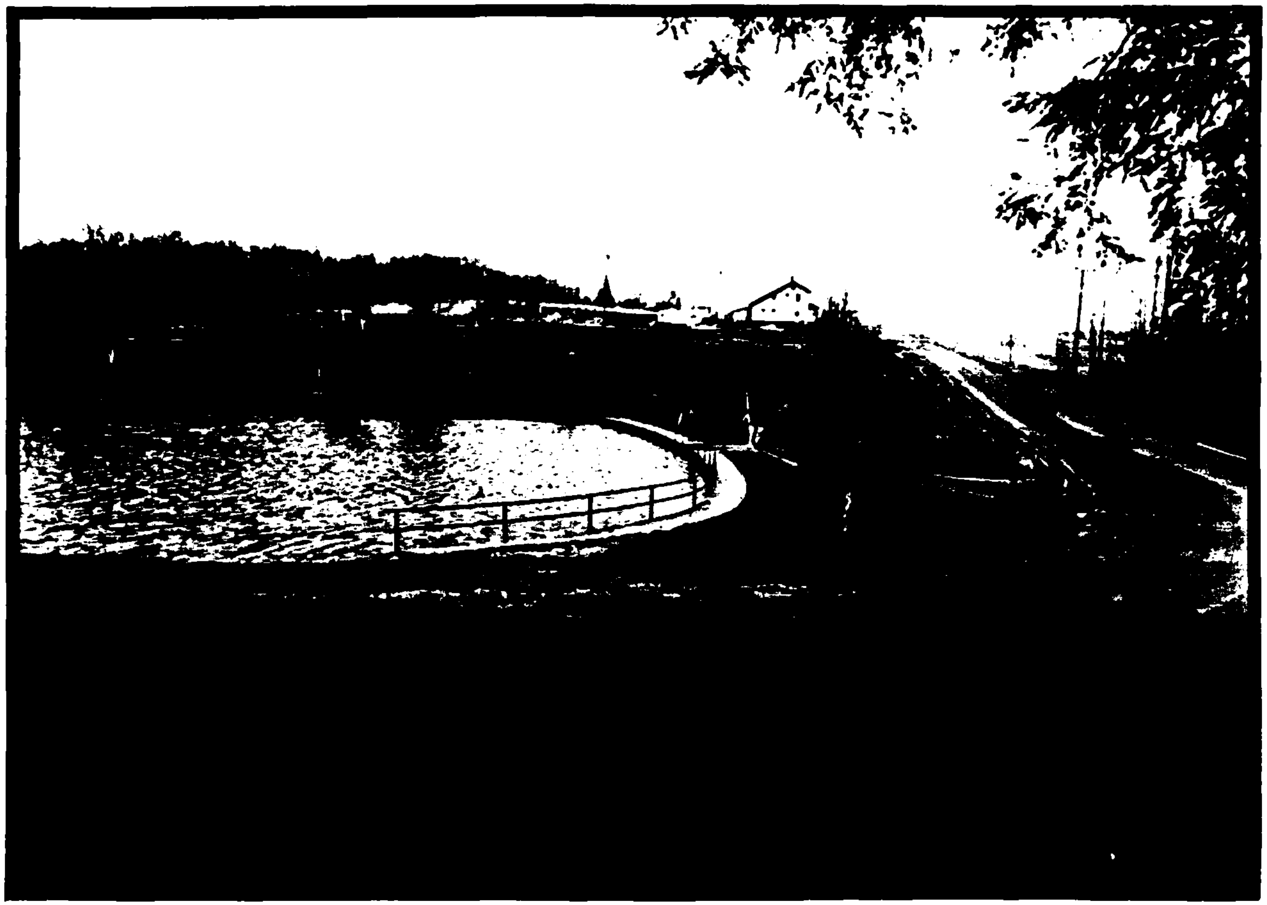

OVERVIEW PHOTOGRAPH

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
TOTEM DAM
NDI# PA-00042, PENNDER# 8-8

SECTION 1
GENERAL INFORMATION

1.0 Authority.

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

1.1 Purpose.

The purpose is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Totem Dam is a very old structure of unusual configuration. Limited data indicate that the embankment is an earth-rockfill type structure, curved in plan, with a concrete, upstream wall providing slope protection and a concrete capped crest (see Overview Photograph). The structure is approximately 12 feet high and 151 feet long, including spillway. The spillway weir is a small, uncontrolled, semi-circular, concrete channel located near the center of the embankment. Flow over the weir enters a rock lined discharge channel and is directed through a 5-foot diameter culvert under the roadway immediately downstream which eventually buttresses or forms the downstream embankment slope. Facilities for reservoir drawdown are provided via an 18-inch diameter outlet conduit with inlet located along the upstream embankment face and discharge outlet located at the lower left spillway channel sidewall. Flow through the pipe is regulated by means of an 18-inch diameter slide gate that is manually operated from atop the embankment crest.

b. Location. Totem Dam is located on Camps Creek in Herrick Township, Bradford County, Pennsylvania, 3.3 miles upstream of the community of Camptown, Pennsylvania. The dam, reservoir, and watershed are contained within the Le Raysville and Rome, Pennsylvania, U.S.G.S. 7.5 minute

topographic quadrangles (see Figure 1, Appendix E). The coordinates of the dam are N41° 45.6' and W76° 14.6'.

c. Size Classification. Small (12 feet high, 132 acre-feet storage capacity at top of dam).

d. Hazard Classification. High (see Section 3.1.e).

e. Owner. Colin M. Townsend
Box 107
Camptown, Pennsylvania 18815

f. Purpose. Private recreation.

g. Historical Data. Available information contained in PennDER files concerning Totem Dam dates back to 1919. At that time, the structure was referred to as an "old dam" owned by William Camp of the nearby community of Rummisfield, Pennsylvania, and was appropriately called Camp Dam. Information is sketchy; however, correspondence indicates that the facility was owned for at least a decade by members of the Connell family from Pottsville and Herrickville, Pennsylvania. In 1958, the facility was acquired from Mary T. Connell by an investment group from Towanda, Pennsylvania consisting of Donald Rueter, Morton Kalin, James R. Strong, and A. B. Duvall who planned to develop the area around the lake as a real estate venture. Until this time, no apparent modifications had ever been made to the facility. The investors proceeded to rehabilitate the facility (with PennDER approval), constructing the upstream concrete wall and crest cap and installing the outlet conduit. The proposed development apparently was unsuccessful and was sold in its entirety in 1966 to its present owner, Colin M. Townsend, who renamed the facility Totem Lake.

Correspondence and discussions with the present owner indicate that the facility has been overtopped at least three times in the last decade. A newspaper clipping from PennDER files, dated June 1972, shows the facility being overtopped and workmen attempting to sandbag the crest. Photographs (also from PennDER files), dated July 1972, indicate that extensive damage from erosion was suffered by the paved roadway section at the toe of the dam but that only minor damage occurred along the major portion of the embankment.

The owner also stated that the embankment overtopped on April 5, 1980, about three weeks prior to the Phase I field inspection. Minor damage was observed and apparently limited to undercutting of the downstream roadway culvert (see

Photograph 9).

1.3 Pertinent Data.

a. Drainage Area (square miles). 1.1.

b. Discharge at Dam Site.

Discharge Capacity of Outlet Conduit - discharge curves are not available.

Discharge Capacity of Spillway at Maximum Pool Z 30 cfs (see Appendix D, Sheet 8).

c. Elevation (feet above mean sea level). The following elevations were obtained through field measurements based on the elevation of normal pool at 1212.0 feet (see Appendix D, Sheets 1 and 2).

Top of Dam	1213.0 (design). 1213.3 (field).
Maximum Design Pool	Not known.
Maximum Pool of Record	1215 (June 1972; estimate).
Normal Pool	1212.0
Spillway Crest	1212.0
Upstream Inlet Invert	1206.0 (design).
Downstream Outlet Invert	1202.0 (design). 1204.8 (field).
Streambed at Dam Centerline	Not known.
Maximum Tailwater	Not known.

d. Reservoir Length (feet).

Top of Dam	3000
Normal Pool	3000

e. Storage (acre-feet).

Top of Dam	132
Normal Pool	92
Design Surcharge	Not known.

f. Reservoir Surface (acres).

Top of Dam	36
Normal Pool	34
Maximum Design Pool	Not known.

g. Dam.

Type	Earth-rockfill.
Length	144 feet (excluding spillway).
Height	12 feet (field measured; embankment crest to invert of spillway channel at road culvert).
Top Width	2 feet.
Upstream Slope	4H:1V (estimated from Figure 2).
Downstream Slope	10H:1V (top of dam to top of road); 1H:1V (top of road to stream invert).
Zoning	Dry rubble wall with earth fill on downstream side and concrete facing (1958) on upstream side (see Figure 4).
Impervious Core	None indicated.
Cutoff	None indicated.
Grout Curtain	None indicated.

h. Diversion Canal and Regulating Tunnels. None.

i. Spillway.

Type	Uncontrolled, semi-circular, concrete channel.

Crest Elevation	1212.0 feet (stop-log in place). 1211.0 feet (stop-log removed).
Crest Length	7.2 feet (top of semi-circle).

j. Outlet Conduit.

Type	18-inch diameter concrete pipe.
Length	100 feet (estimated).
Closure and Regulating Facilities	Control is provided by 18-inch diameter slide gate mounted on the upstream face of the facing wall and operated from the embankment crest.
Access	The manual operator is easily accessible by foot along the embankment crest.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Design Data Availability and Sources. No formal design reports or calculations are available for any aspect of this facility. Design drawings and specifications relative to modifications made in 1959-1960 are contained in PennDER files.

b. Design Features.

1. Embankment. Information concerning the design, construction, and/or composition of this facility is very limited. No drawings of the embankment cross-section are available. Information gathered from the owner and inferred from available correspondence indicate the embankment is an earth-rockfill type structure, with earth comprising the downstream portion and a dry rubble rock wall the upstream portion. The concrete wall and crest cap constructed along the curved embankment centerline were added as a modification to the original facility in 1959 (see Figure 2). There is no indication that the wall was designed to serve any purpose other than upstream slope protection (see Figure 4). Contours of the reservoir near the dam were apparently recorded and drafted when the reservoir was drawndown in 1959 during rehabilitation. The contours (shown on Figure 2) imply that there is a 4H:1V slope upstream of the rubble wall, presumably of soil, or that the reservoir is an incised natural lake.

2. Appurtenant Structures.

a. Spillway. The spillway is a small, uncontrolled, semicircular, concrete channel located near the center of the embankment (see Figure 2). The small flows capable of being discharged through the structure are regulated by a 12-inch stop-log that serves as a small weir. The discharge channel is constructed of concrete with hand-placed, unmortared, rock sidewalls. No spillway details are available.

b. Outlet Conduit. The outlet conduit reportedly consists of an 18-inch diameter concrete pipe. The conduit was installed in 1959-1960, prior to which there was no means for drawing down the reservoir other than by controlled breaching. Figures 2 through 4 depict the proposed installation of the conduit; however, visual observa-

tions made during the inspection indicate the drawings do not represent as-built conditions.

c. Specific Design Data and Criteria. No design data or information relative to design procedures is available.

2.2 Construction Records.

No construction records are available for the facility pertaining to either its original construction or the modification work performed in 1959-1960.

2.3 Operational Records.

No records of the day-to-day operation of the facility are maintained.

2.4 Other Investigations.

There are no available records concerning formal studies or investigations of Totem Dam other than several routine state inspection reports contained in PennDER files dating back to 1915. Eleven photographs dating to 1919 are available from PennDER files which provide some historical insight.

2.5 Evaluation.

Available data relative to Totem Dam is very limited. There are no drawings available that formally depict the cross-section and internal features of the facility. Thus, an assessment of the overall design or, moreover, the integrity of the structure during overtopping is highly speculative. Outlet conduit details presented on available drawings differ with field observed site conditions.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General. The overall appearance of the facility suggests the dam and its appurtenances are currently in fair condition.

b. Embankment. Observations made during the visual inspection indicate the embankment is in good condition. The most visually apparent deficiency observed concerned cracking of the upstream concrete wall and crest cap. A 25-foot longitudinal crack is located several feet from the left abutment (see Photograph 3) while an additional area of broken concrete is located about 10 feet from the right abutment (see Photographs 2 and 4). Minor cracking was also observed along the wall below the pool level between the spillway and right abutment.

The downstream portion of the embankment appears to be comprised primarily of rockfill covered with a thin turf layer. The recent overtopping incident removed small patches of the turf exposing the rock below. The condition was particularly evident along the areas adjacent to the spillway channel sidewalls. The owner has backfilled these areas of open flow erosion with rock and, consequently, the condition is not considered a major deficiency.

c. Appurtenant Structures.

1. Spillway. The visual inspection revealed the spillway is in fair condition. Cracking along its downstream face was observed, but, is not considered significant at this time (see Photograph 5 and 6). A crack observed at the contact of the spillway downstream face and discharge channel floor appeared to be leaking; however, it is noted that leakage at this contact area has been consistently noted in previous state inspection reports dating as far back as 1919. Outflow from the spillway is directed through a 5-foot diameter highway culvert prior to discharging into Camps Creek (see Photographs 6, 9, and 10). It was noted that the outlet endwall had been undercut and is subject to further erosion.

2. Outlet Conduit. The outlet conduit is considered to be in fair condition. The conduit was not operated in the presence of the inspection team. Furthermore, the conduit reportedly has never been opened by the present

owner who acquired the facility in 1966. Consequently, its operability is questionable. The gate control along the upstream embankment face appears securely mounted; however, some surficial corrosion was observed (see Photograph 7). Minor leakage was observed at the discharge end of the conduit, but, was not measurable (see Photograph 8). The apparent plan of the outlet conduit does not conform to the design drawings.

d. Reservoir Area. The general area surrounding the reservoir is composed of moderate to steep slopes that are primarily wooded (see Photograph 1). The entire watershed is about 50 percent wooded as shown in Figure 1.

e. Downstream Channel. The channel downstream of Totem Dam is characterized as steep and narrow with steep confining slopes. The stream passes through the community of Camptown, Pennsylvania approximately 3.3 miles downstream. Here at least 12 structures, including two churches, a hardware store, a post office and several homes, are located sufficiently near the stream to possibly be affected by the high waters associated with an embankment breach. It is estimated that 25 to 100 lives could be lost and significant economic damage incurred as the result of an embankment breach.

3.2 Evaluation.

The overall condition of the facility is considered fair. Specific deficiencies noted by the inspection team include concrete deterioration associated with the facing wall, crest cap, and downstream spillway face; possible leakage under the spillway slab; and a possibly inoperable outlet conduit. Remedial action is recommended to rectify each of the above conditions.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

Totem Dam is essentially a self-regulating facility. Excess inflow is automatically discharged through the uncontrolled spillway and directed downstream. The outlet conduit is currently closed and its operability questionable. No formal operating manual is available.

4.2 Maintenance of Dam.

The embankment is maintained on an unscheduled and informal basis. Basic maintenance such as mowing the embankment, keeping the spillway clear, and repairing minor flood damage is performed by the owner as needed at his convenience. No formal maintenance manual is available.

4.3 Maintenance of Operating Facilities.

The outlet conduit has not been operated since the present owner acquired the facility in 1966. No preventive maintenance has been performed on this appurtenance by the present owner.

4.4 Warning System.

No formal warning system is in effect.

4.5 Evaluation.

Routine maintenance of the facility appears adequate; however, restoration of the outlet conduit and repairs to the concrete embankment crest are required. Formal manuals of maintenance and operation are also recommended to ensure that all needed maintenance is identified and performed regularly. In addition, a formal warning system for the protection of downstream inhabitants should be developed. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

SECTION 5
HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

No formal design reports, calculations, or miscellaneous design data are available for the facility.

5.2 Experience Data.

Totem Dam has a history of infrequent incidents of overtopping. Within the last 10 years the facility has been overtopped at least three times; June 1972, October 1975, and most recently on April 5, 1980 (19 days prior to this inspection).

The inspection team observed no apparent damage from the most recent incident.

Photographs documenting the aftermath of the flood of June 1972, as well as a newspaper clipping showing the embankment being overtopped, are contained in PennDER files. Once again, apparently no significant damage to the embankment occurred although water was unofficially reported to be flowing in excess of two feet over the embankment crest. The bituminous roadway immediately below the dam was partially washed out.

No other records of past performance are available.

5.3 Visual Observations.

On the date of the inspection, no conditions were observed that would indicate the spillway could not function satisfactorily during a flood event, within the limits of its design capacity. Undercutting of the downstream endwall of the highway culvert was observed, indicating the potential for erosion of the downstream area under large flows.

5.4 Method of Analysis.

The facility has been analyzed in accordance with procedures and guidelines established by the U. S. Army, Corps of Engineers, Baltimore District, for Phase I hydrologic and hydraulic evaluations. The analysis has been performed using a modified version of the HEC-1 program developed by

the U. S. Army, Corps of Engineers, Hydrologic Engineering Center, Davis, California. Analytical capabilities of the program are briefly outlined in the preface contained in Appendix D.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF). In accordance with the procedures and guidelines contained in the National Guidelines for Safety Inspection of Dams for Phase I Investigations, the Spillway Design Flood (SDF) for Totem Dam ranges between the 1/2-PMF (Probable Maximum Flood) and the PMF. This classification is based on the relative size of the dam (small), and the potential hazard of dam failure to downstream developments (high). Due to the high potential for damage to downstream structures and possibly loss of life, the SDF for this facility is considered to be the PMF.

b. Results of Analysis. Totem Dam was evaluated under normal operating conditions. That is, the reservoir was initially at its normal pool or spillway elevation of 1212.0 feet, with the spillway weir discharging freely. The outlet conduit was assumed to be non-functional for the purpose of analysis, since the flow capacity of the conduit is not such that it would significantly increase the total discharge capabilities of the dam and reservoir. The spillway consists of a concrete free overfall structure, with discharges regulated by a wooden stop-log. The spillway discharge is conveyed through the roadway embankment immediately downstream of the dam via a 5-foot diameter CMP culvert. All pertinent engineering calculations relative to the evaluation of Totem Dam are provided in Appendix D.

Overtopping analysis (using the Modified HEC-1 Computer Program) indicated that the discharge/storage capacity of Totem Lake Dam can accommodate only about two percent of the PMF (SDF) prior to embankment overtopping. It is also noted that the downstream roadway embankment can accommodate only about 11 percent of the PMF prior to overtopping. Under PMF conditions, the top of Totem Dam was inundated by depths of up to 3.0 feet, and by depths of up to 1.9 feet under 1/2-PMF conditions (Appendix D, Summary Input/Output Sheets, Sheet H). Since the SDF for Totem Lake Dam is the PMF, it can be concluded that this dam has a high potential for overtopping, and thus, for breaching under floods of less than SDF magnitude.

As Totem Dam cannot accommodate floods of at least 1/2-PMF magnitude, the possibility of embankment failure under floods of less than 1/2-PMF intensity was investigated (in accordance with Corps directive ETL-1110-2-234). The modified HEC-1 Computer Program was used for the breaching analysis, with the assumption that the downstream channel bed was dry prior to the occurrence of the dam outflows. The major concern of the breaching analysis is with the impact of the various breach discharges on increasing downstream water surface elevations above those to be expected if breaching did not occur.

The portion of Totem Dam which is most likely to fail due to overtopping is the area around the spillway structure, due to the possible erosion and collapse of the rock walls lining the spillway channel (see Photographs 5, 6). Likewise, the roadway embankment is most likely to fail in the area of the culvert, as the downstream face is unprotected and highly erodible by overtopping water.

Two breach models were analyzed for Totem Dam, involving one breach section and two possible failure times. The breach section chosen was considered to be an average possible section at the spillway structure. The two failure times (total time for breach section to reach its final dimensions) were assumed to be a rapid time (0.5 hours) and a prolonged time (4.0 hours), so that a range of this most sensitive variable might be examined. It was assumed that the downstream roadway embankment had breached significantly prior to the failure of the main dam, or breached simultaneously with the main dam, so that it could be ignored in the analysis.

The breaching analysis was made under 0.15 PMF conditions, and it was assumed that the failure would begin as the depth of overtopping reached about 0.5 feet. The peak breach outflows ranged from about 940 cfs for the prolonged time scheme to about 2350 cfs for the rapid failure scheme, compared to the non-breach 0.15 PMF peak outflow of about 380 cfs (Appendix D, Sheet 25).

The principal center of damage investigated is located along the banks of Camps Creek in the downstream community of Camptown (Sections 4, 5; see Figure 1). Within this reach, the 0.15 PMF non-breach outflows remained within the banks of the stream. However, the maximum water surface elevations (at Section 5) corresponding to the breach outflows were about 2.1 and 3.2 feet above the stream banks, and thus, well above the damage levels of the nearby structures (Appendix D, Sheet 25).

The consequences of dam failure can better be envisioned if not only the increase in the height of the floodwave is considered, but also the great increase in momentum of the larger and probably swifter moving volume of water. Therefore, the failure of Totem Dam would most likely lead to increased property damage and possibly to loss of life in the downstream community.

5.6 Spillway Adequacy.

As presented previously, Totem Dam can accommodate only about two percent of the PMF (SDF) prior to embankment overtopping. In addition, the roadway embankment immediately downstream of the dam can accommodate only about 11 percent of the PMF prior to overtopping. It has been shown that should a 0.15 PMF or larger event occur, the dam would be overtopped and could possibly fail, endangering downstream residences and increasing the potential for loss of life in the downstream regions. Therefore, the spillway is considered to be seriously inadequate.

SECTION 6
EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Embankment. Based on visual observations, the embankment is in good condition. The major deficiency observed by the inspection team concerned cracking associated with the concrete upstream wall and crest cap. Since the wall was designed to serve as slope protection against wave action and not as an impervious internal boundary or structural revetment, the deterioration is considered minor. Nevertheless, the condition does require remedial attention.

b. Appurtenant Structures.

1. Spillway. The spillway is considered to be in fair condition. Cracking observed in the structure should be repaired although it does not appear to present a threat to the stability of the structure at this time. Under normal flow conditions the dry rubble walls of the spillway channel appear to be sufficiently stable; however, under overtopping conditions (which are not unusual) it is possible that the walls could collapse, endangering the integrity of the embankment. In addition, erosion from overtopping appears possible on the downstream (outlet) side of the roadway embankment which in effect acts as a buttress to the dam. To preclude failure from overtopping, it would appear prudent to adequately support and protect the spillway walls and downstream roadway slope from erosion.

2. Outlet Conduit. The condition of the outlet conduit is considered fair although its current operability is questionable. The operation of the conduit should be checked at least once a year and repairs made annually, if needed.

6.2 Design and Construction Techniques.

No information is available that details the methods of design and/or construction.

6.3 Past Performance.

Totem Dam has a history of infrequent incidents of overtopping. Within the last 10 years the facility has been overtopped at least three times; June 1972, October 1975,

and most recently on April 5, 1980 (19 days prior to this inspection).

The inspection team observed no apparent major damage from the most recent incident.

Photographs documenting the aftermath of the flood of June 1972, as well as a newspaper clipping showing the embankment being overtopped, are contained in PennDER files. Once again, apparently no significant damage to the embankment occurred although water was unofficially reported to be flowing in excess of two feet over the embankment crest. The bituminous roadway immediately below the dam was partially washed out.

No other records of past performance are available.

6.4 Seismic Stability.

The dam is located in Seismic Zone No. 1 and is subject to minor earthquake induced dynamic forces. As the facility appears sufficiently stable, it is believed that it can withstand the expected dynamic forces; however, no calculations and/or investigations were performed to confirm this opinion.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The results of this investigation indicate the dam is considered to be in fair condition.

The size classification of the facility is small and its hazard classification is considered to be high. In accordance with the recommended guidelines, the Spillway Design Flood (SDF) for the facility ranges between the 1/2-PMF (Probable Maximum Flood) and the PMF. Due to the high potential for damage to downstream structures and loss of life that could be associated with a sudden embankment breach, the SDF is considered to be the PMF. Results of the hydrologic and hydraulic analysis indicate the facility will pass and/or store only two percent of the PMF prior to embankment overtopping.

The embankment has, in fact, been overtopped at least three times in the past decade. However, due to its unusual configuration, damage has been limited to scouring of the embankment and downstream roadway. Breach analyses performed in this study indicate that there are conditions for floods of less than 1/2-PMF magnitude during which the embankment could possibly fail and result in an increased potential for damage and loss of life downstream . Thus, the spillway system is considered to be seriously inadequate and the facility unsafe, non-emergency.

b. Adequacy of Information. The available data are considered sufficient to make a reasonable Phase I assessment of the facility.

c. Urgency. Recommendations listed below should be implemented immediately.

d. Necessity for Additional Investigation. Additional studies to assess the hydraulic adequacy and/or integrity of the embankment under conditions of overtopping are considered necessary.

7.2 Recommendations/Remedial Measures.

It is recommended that the owner immediately:

a. Develop a formal emergency warning system for the notification of downstream residents in the event hazardous conditions develop. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

b. Have the facility evaluated by a registered professional engineer experienced in the hydraulics and hydrology of dams to further assess the adequacy of the spillway and take remedial measures deemed necessary to make the facility hydraulically adequate.

c. Repair concrete deterioration wherever necessary, including along the crest and downstream spillway face.

d. Check the present operability of the outlet conduit control valve and initiate repairs, if necessary. In addition, the conduit should be operated on at least an annual basis and preventive maintenance performed concurrently.

e. Formalize manuals of operation and maintenance to ensure proper future care of the facility.

APPENDIX A

VISUAL INSPECTION CHECKLIST AND FIELD SKETCHES

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM Totem Dam STATE Pennsylvania COUNTY Bradford

NDI # PA — 00042 PENNDER # 8-8

TYPE OF DAM Earth-Rockfill SIZE Small HAZARD CATEGORY High

DATE(S) INSPECTION 24 April 1980 WEATHER Sunny TEMPERATURE 65° @ 12:30 p.m.

POOL ELEVATION AT TIME OF INSPECTION 1212.1 feet M.S.L.

TAILWATER AT TIME OF INSPECTION N/A M.S.L.

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	OTHERS
B. M. Mihalcin	Colin Townsend	
D. J. Spaeder		
D. L. Bonk		

RECORDED BY D. L. Bonk

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA- 00042
SURFACE CRACKS	Longitudinal crack (25'long) observed in concrete crest cap beginning 5 feet from the left abutment. Additional area of broken concrete located about 10 feet from right abutment. Cracking observed in upstream concrete face for about 70 feet from right abutment.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Evidence of minor erosion of soil cover atop downstream rock face was observed. Condition reportedly resulted from overtopping incident caused by torrential rains several weeks ago. Erosion particularly evident adjacent spillway wingwalls.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Vertical - good (concrete crest). Horizontal - good (arched design).
RIPRAP FAILURES	N/A.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good condition.

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00042
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	None observed.
ANY NOTICEABLE SEEPAGE	None observed.
STAFF GAGE AND RECORDER	None.
DRAINS	None observed.

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00042
INTAKE STRUCTURE	Submerged intake, not observed.
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	Not observed. Minor leakage observed at discharge end.
OUTLET STRUCTURE	No outlet structure. Outlet discharges through left sidewall of spillway channel.
OUTLET CHANNEL	See "Discharge Channel" Sheet 5 of 8.
GATE(S) AND OPERATIONAL EQUIPMENT	Gate mounted on upstream embankment face about 12 feet from the left abutment. Never operated by present owner. Corrosion observed.
MISCELLANEOUS	Field location of outlet pipe does not agree with design drawings. Location apparently changed during construction.

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA- 00042
TYPE AND CONDITION	Semi-circular concrete channel located near the center of the embankment. Fair condition. Concrete cracking in evidence along downstream discharge face.
APPROACH CHANNEL	N/A.
SPILLWAY CHANNEL AND SIDEWALLS	Hand-placed, rubble rock sidewalls between outlet of semi-circular channel and roadway downstream, except for the lower portion of the left sidewall which contains the outlet and is constructed of concrete.
STILLING BASIN PLUNGE POOL	N/A.
DISCHARGE CHANNEL	Flow from spillway structure is directed under roadway embankment via 5-foot diameter culvert pipe. Downstream endwall of culvert has been undercut by discharge and appears susceptible to further erosion.
BRIDGE AND PIERS EMERGENCY GATES	None.

SERVICE SPILLWAY

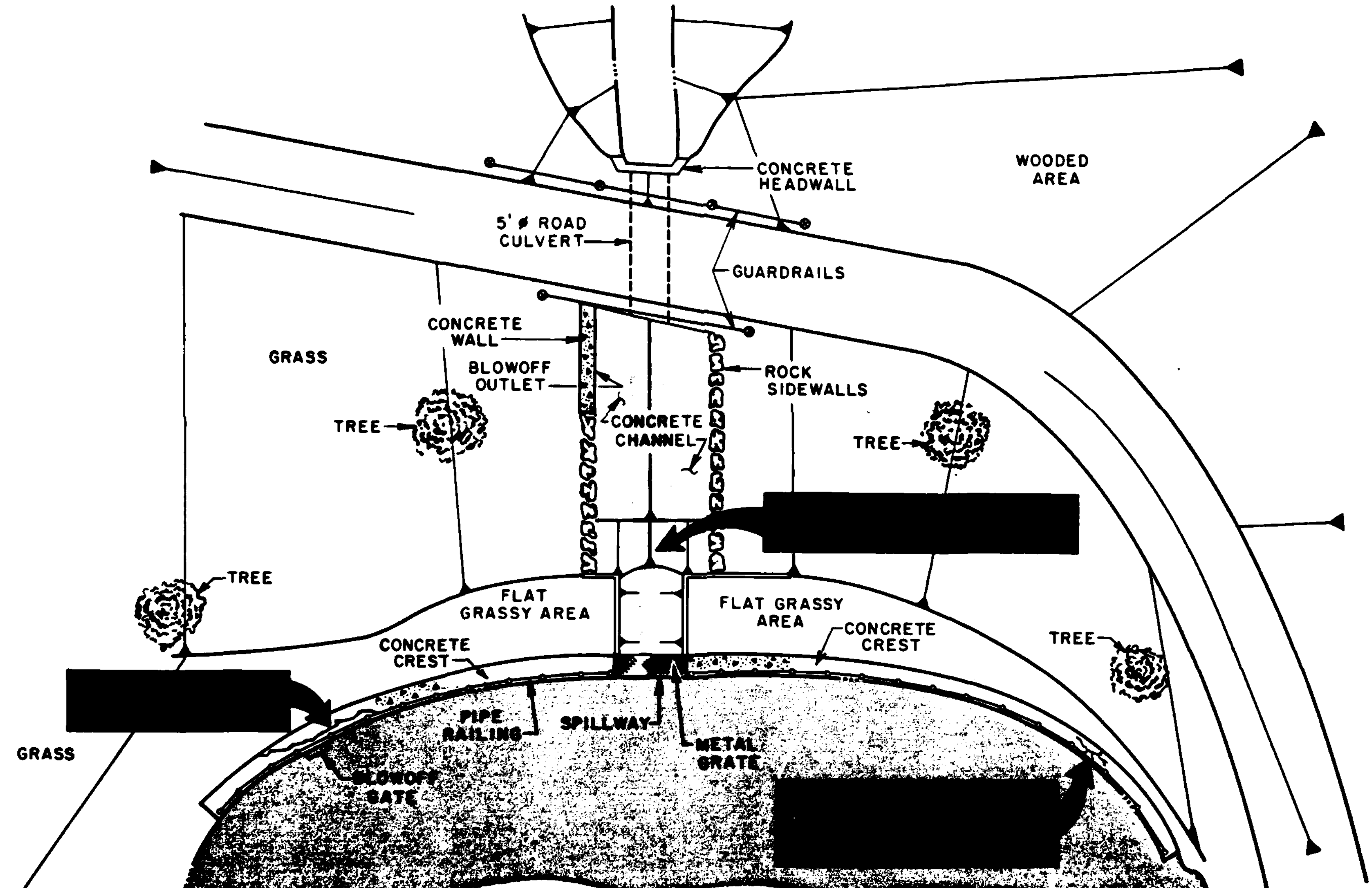
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00042
TYPE AND CONDITION	N/A.
APPROACH CHANNEL	N/A.
OUTLET STRUCTURE	N/A.
DISCHARGE CHANNEL	N/A.

INSTRUMENTATION

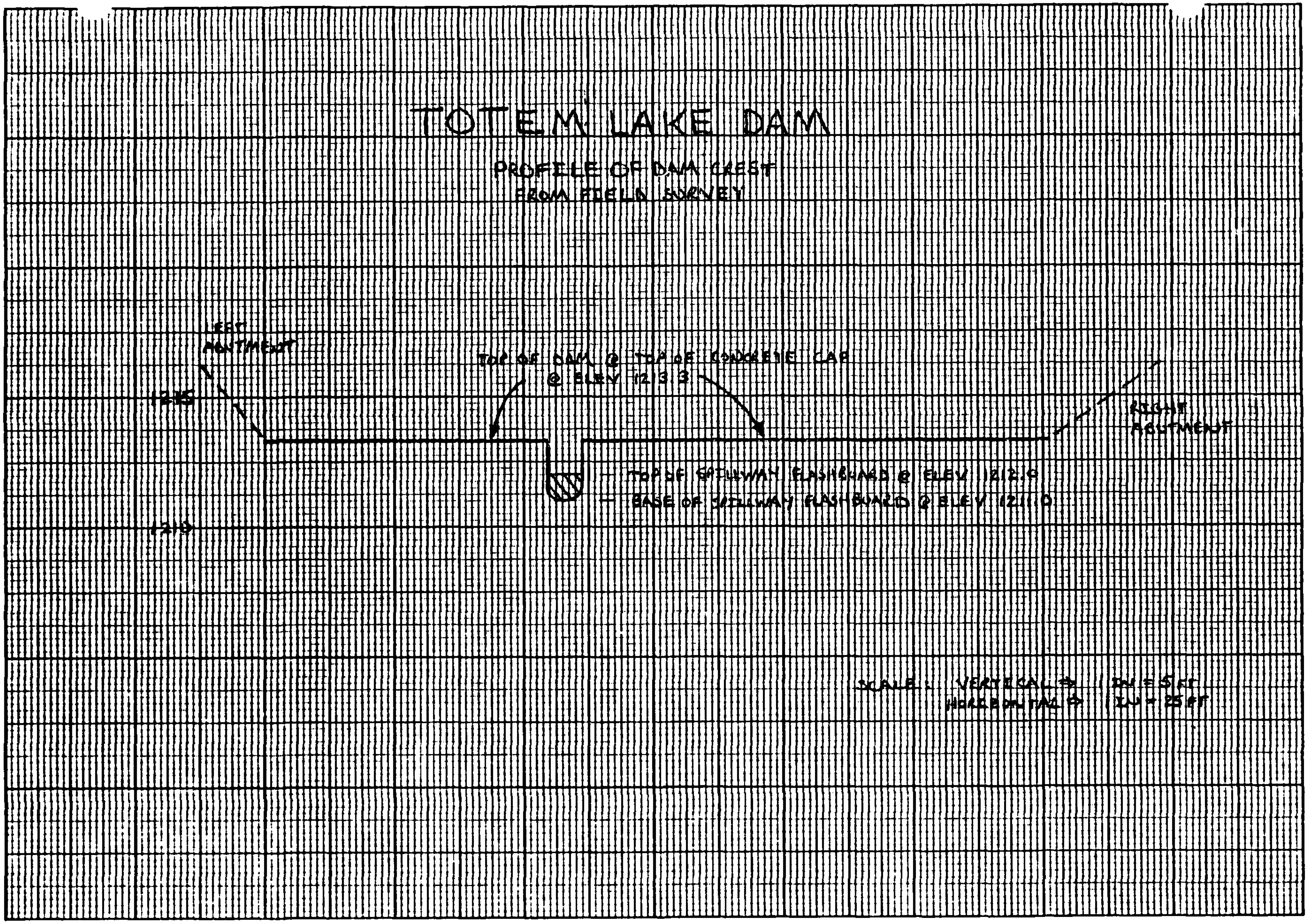
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00042
MONUMENTATION SURVEYS	None.
OBSERVATION WELLS	None.
WEIRS	None.
PIEZOMETERS	None.
OTHERS	

RESERVOIR AREA AND DOWNSTREAM CHANNEL

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00042
SLOPES: RESERVOIR	Moderate to steep and primarily forested, except for immediate northern slope which has been cleared.
SEDIMENTATION	Not known.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	Natural stream with no apparent obstructions between dam and village of Camptown.
SLOPES: CHANNEL VALLEY	Valley and channel slopes are steep until stream enters village of Camptown where the valley widens and becomes very flat.
APPROXIMATE NUMBER OF HOMES AND POPULATION	Approximately 12 structures including 2 churches, a general store, and post office are contained in the floodplain of Camps Creek in the community of Camptown. Approximate residents 50 to 100.



TOTEM LAKE DAM
GENERAL PLAN - FIELD INSPECTION NOTES


TOTEM LAKE DAM
PROFILE OF DAM CREST
FROM FIELD SURVEY
LEFT ABUTMENT
TOP OF DAM @ TOP OF CONCRETE CAP
@ ELEV 1213.3
RIGHT ABUTMENT
1215
TOP OF SPILLWAY FLASHBOARD @ ELEV 1212.9
BASE OF SPILLWAY FLASHBOARD @ ELEV 1211.0
1210
SCALE: VERTICAL ⇒ 1 IN = 5 FT
HORIZONTAL ⇒ 1 IN = 25 FT

APPENDIX B

ENGINEERING DATA CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM Totem Dam

ITEM	REMARKS NDI# PA- 00042
PERSONS INTERVIEWED AND TITLE	Colin Townsend - owner (since March 1966).
REGIONAL VICINITY MAP	See Appendix E, Figure 1.
CONSTRUCTION HISTORY	Dam was referred to as an old structure in 1919. Upstream concrete facing wall and outlet conduit were constructed and installed in 1959-1960.
AVAILABLE DRAWINGS	Set of 4 drawings, dated 9-8-59, by Miller-Shaylor Associates of Towanda, Pennsylvania are contained in PennDER files. These drawings contain details of the proposed outlet conduit construction.
TYPICAL DAM SECTIONS	None available.
OUTLETS: PLAN DETAILS DISCHARGE RATINGS	The present outlet conduit is not depicted in the available drawings. Discharge rating curves are not available.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

NDI# PA - 00042

ITEM	REMARKS
SPILLWAY: PLAN SECTION DETAILS	See Appendix E, Figure 2.
OPERATING EQUIPMENT PLANS AND DETAILS	None available.
DESIGN REPORTS	None available.
GEOLOGY REPORTS	None available.
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	None available.
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	None available.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA - 00042
BORROW SOURCES	Not known.
POST CONSTRUCTION DAM SURVEYS	None.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.
HIGH POOL RECORDS	Embankment was overtopped in June 1972, October 1975, and most recently on April 5, 1980. Depth of overtopping not recorded; however, it is reported that the June 1972 flood resulted in overtopping in excess of 2 feet.
MONITORING SYSTEMS	None.
MODIFICATIONS	Upstream concrete wall and outlet conduit were constructed and installed in 1959-1960. Records of the modifications are very limited.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA - 00042
PRIOR ACCIDENTS OR FAILURES	No significant damage resulted from recent overtopping incident in April 1980. Overtopping in June 1972 resulted in damage to the downstream roadway embankment.
MAINTENANCE: RECORDS MANUAL	Routine maintenance is performed on an unscheduled basis.
OPERATION: RECORDS MANUAL	No formal manual. Operating records are not kept.
OPERATIONAL PROCEDURES	Facility is essentially self-regulating. Blowoff has never been operated by the present owner and is currently inoperable.
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	None.
MISCELLANEOUS	

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CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # PA-00042
PENNDER ID # 8-8

SIZE OF DRAINAGE AREA: 1.1 square miles.

ELEVATION TOP NORMAL POOL: 1212.0 STORAGE CAPACITY: 92 acre-feet.

ELEVATION TOP FLOOD CONTROL POOL: - STORAGE CAPACITY: -

ELEVATION MAXIMUM DESIGN POOL: - STORAGE CAPACITY: -

ELEVATION TOP DAM: 1213.3 STORAGE CAPACITY: 132 acre-feet.

SPILLWAY DATA

CREST ELEVATION: 1212.0 feet.

TYPE: Uncontrolled, semi-circular concrete channel.

CREST LENGTH: 7.2 feet at top of semi-circle.

CHANNEL LENGTH: ≈ 60 feet.

SPILLOVER LOCATION: Center of dam.

NUMBER AND TYPE OF GATES: None.

OUTLET WORKS

TYPE: 18-inch diameter concrete pipe.

LOCATION: near left abutment.

ENTRANCE INVERTS: 1206.0 feet (design).

EXIT INVERTS: 1202.0 feet (design); 1204.8 (field).

EMERGENCY DRAWDOWN FACILITIES: 18-inch diameter slide gate at inlet.

HYDROMETEOROLOGICAL GAGES

TYPE: None.

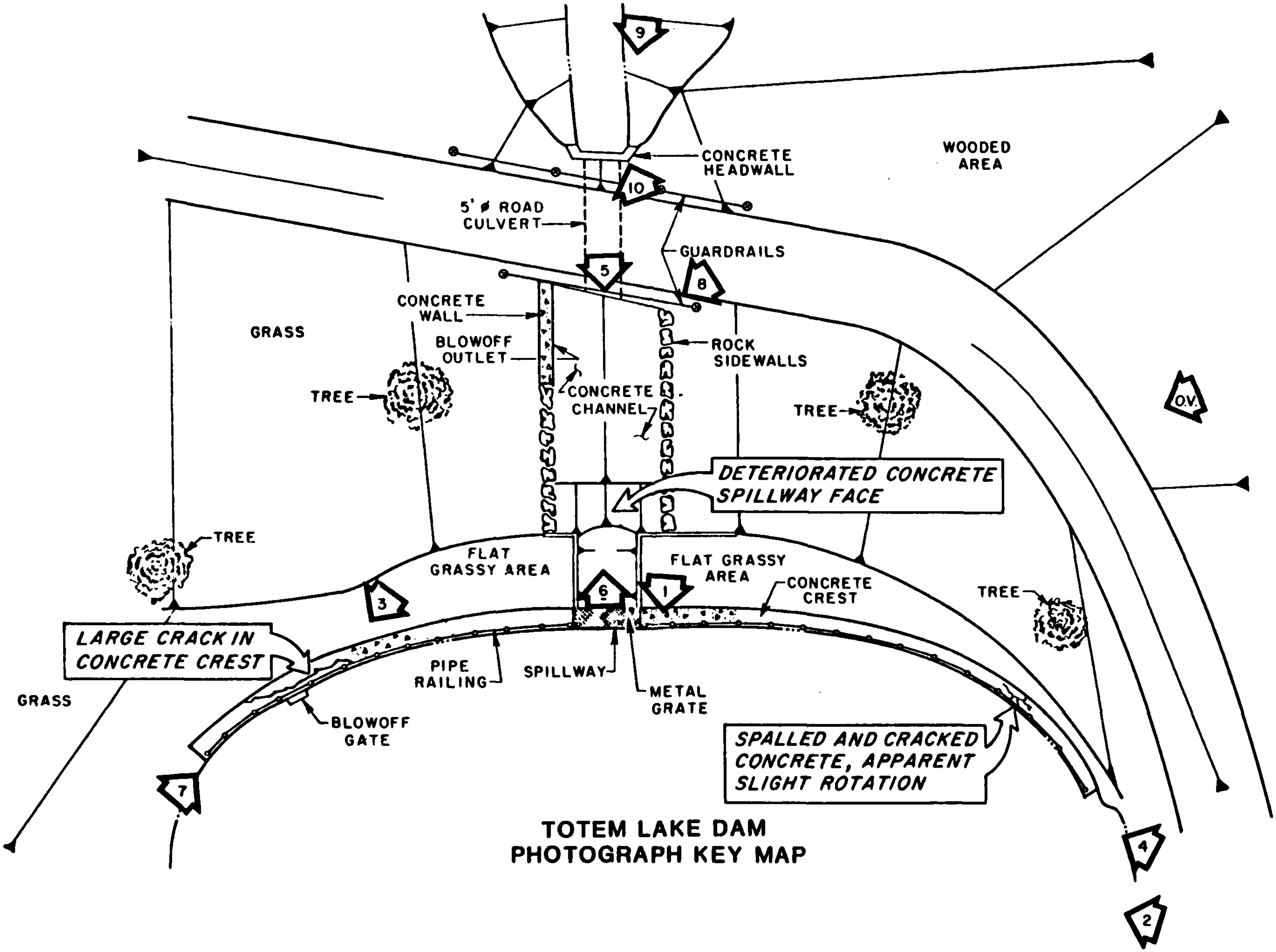
LOCATION: -

RECORDS: -

MAXIMUM NON-DAMAGING DISCHARGE: Overtopped by about 2 feet in June 1972.

APPENDIX C

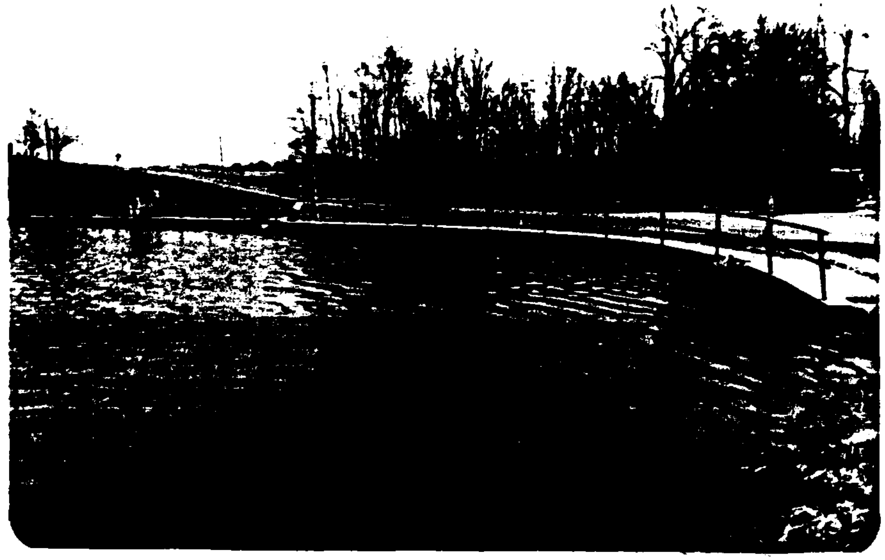
PHOTOGRAPHS



TOTEM LAKE DAM
PHOTOGRAPH KEY MAP

PHOTOGRAPH 1	View of Totem Lake as seen from the embankment crest.
PHOTOGRAPH 2	View of the upstream face of Totem Dam as seen from the right abutment.
PHOTOGRAPH 3	View of a structural crack in the concrete crest cap near the left abutment.
PHOTOGRAPH 4	View of a damaged portion of concrete along the dam crest near the right abutment.

1



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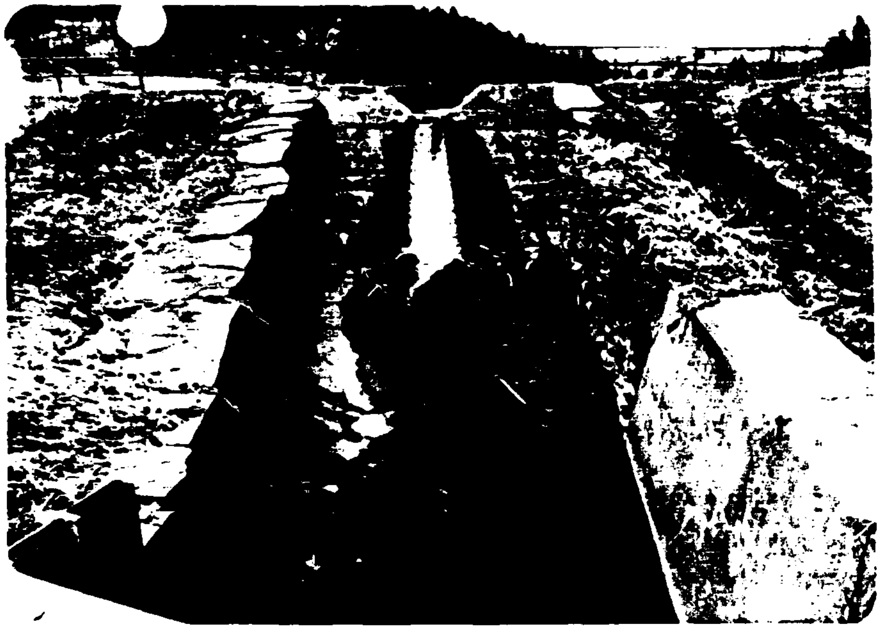
PHOTOGRAPH 5	View of the spillway looking upstream from the road just downstream of the dam.
PHOTOGRAPH 6	View of the road and culvert downstream of the dam as seen from the embankment crest.
PHOTOGRAPH 7	View of the upstream dam face between the spillway and left abutment. The valve stem for the outlet conduit control valve is mounted on the upstream face in the center of the view.
PHOTOGRAPH 8	View of the discharge end of the outlet conduit located in the left downstream spillway sidewall (far right-center portion of view).



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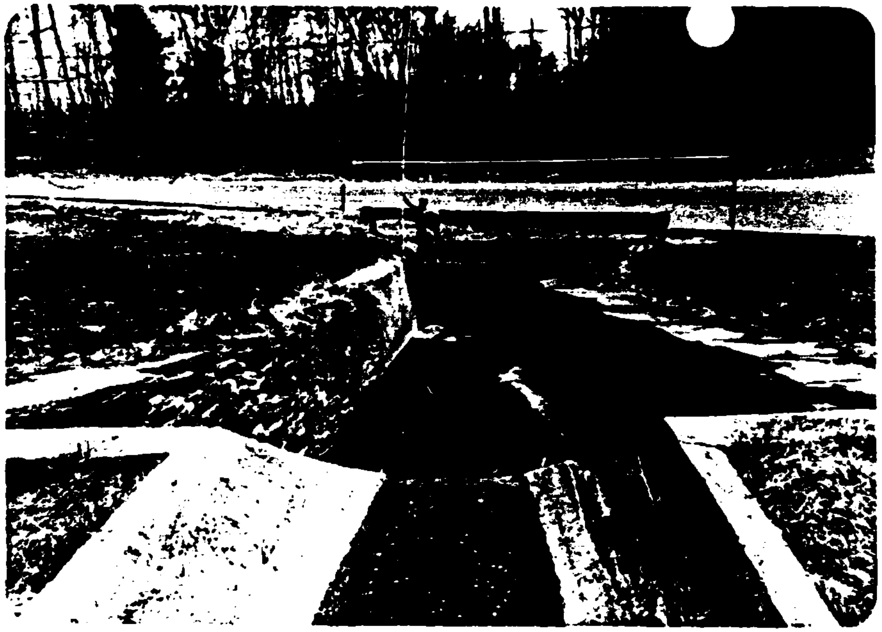

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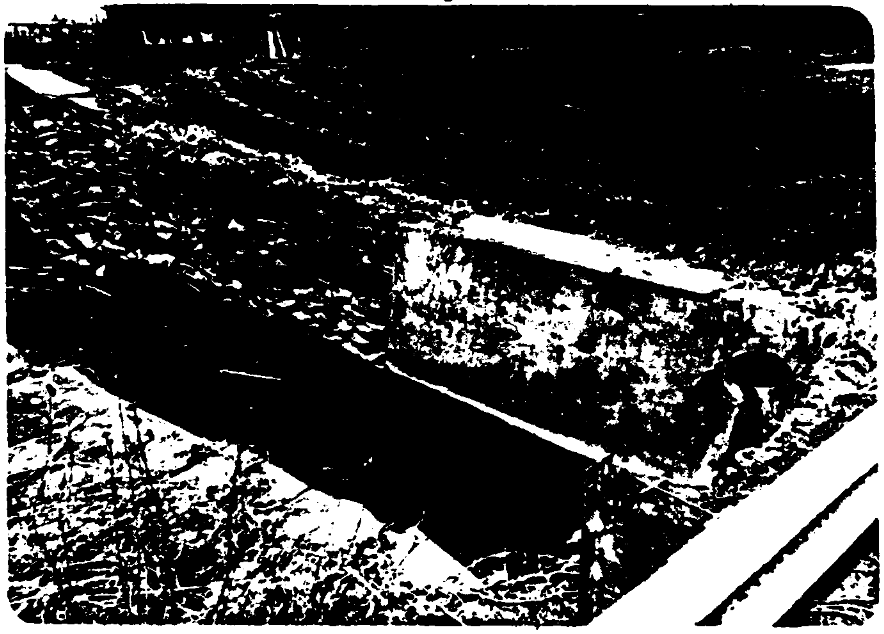

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PHOTOGRAPH 9	View of the downstream end of the roadway culvert shown in Photograph 6.
PHOTOGRAPH 10	View, looking downstream, of the channel immediately below the embankment.
PHOTOGRAPH 11	View of the stream channel about three miles downstream in the community of Camptown, Pennsylvania.
PHOTOGRAPH 12	View of the main intersection in Camptown. The white building in the view experienced high water during the major floods of June 1972 and October 1975.

9

10

11

12

APPENDIX D

HYDROLOGY AND HYDRAULICS ANALYSES

PREFACE

The modified HEC-1 program is capable of performing two basic types of hydrologic analyses: 1) the evaluation of the overtopping potential of the dam; and 2) the estimation of the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. Briefly, the computational procedures typically used in the dam overtopping analysis are as follows:

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.

c. Routing of the outflow hydrograph(s) from the reservoir to desired downstream locations. The results provide the peak discharge(s), time(s) of the peak discharge(s), and the maximum stage(s) of each routed hydrograph at the downstream end of each reach.

The evaluation of the hydrologic-hydraulic consequences resulting from an assumed structural failure (breach) of the dam is typically performed as shown below.

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir.

c. Development of a failure hydrograph(s) based on specified breach criteria and normal reservoir outflow.

d. Routing of the failure hydrograph(s) to desired downstream locations. The results provide estimates of the peak discharge(s), time(s) to peak and maximum water surface elevations of failure hydrographs for each location.

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: TOTEM LAKE DAM

PROBABLE MAXIMUM PRECIPITATION (PMP) = 22.2 INCHES/24 HOURS [1]

STATION	1	2	3
STATION DESCRIPTION	TOTEM LAKE DAM		
DRAINAGE AREA (SQUARE MILES)	1.1		
CUMULATIVE DRAINAGE AREA (SQUARE MILES)	-		
ADJUSTMENT OF PMF FOR DRAINAGE AREA LOCATION (%) [1]			
6 HOURS	113		
12 HOURS	122		
24 HOURS	131		
48 HOURS	137		
72 HOURS	139		
SNYDER HYDROGRAPH PARAMETERS			
ZONE (2)	11		
C_p (3)	0.62		
C_t (3)	1.50		
L (MILES) (4)	1.8		
L_{ca} (MILES) (4)	0.8		
$t_p = C_t\ (L \cdot L_{ca})^{0.3}$ (HOURS)	1.67		
SPILLWAY DATA			
CREST LENGTH (FEET)	5.2		
FREEBOARD (FEET)	1.3		

(1) HYDROMETEOROLOGICAL REPORT - 40, U.S. WEATHER BUREAU, 1965.

(2) HYDROLOGIC ZONE DEFINED BY CORPS OF ENGINEERS, BALTIMORE DISTRICT, FOR DETERMINATION OF SNYDER COEFFICIENTS (C_p AND C_t).

(3) SNYDER COEFFICIENTS

(4) L = LENGTH OF LONGEST WATERCOURSE FROM DAM TO BASIN DIVIDE.
L_{ca} = LENGTH OF LONGEST WATERCOURSE FROM DAM TO POINT OPPOSITE BASIN CENTROID.

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY RJS DATE 6-13-80 PROJ. NO. 79-303-042
CHKD. BY WJV DATE 7-31-80 SHEET NO. 1 OF 25

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DAM STATISTICS

- HEIGHT OF DAM = 12 FT (FIELD MEASURED: TOP OF DAM TO INVERT OF SPILLWAY CHANNEL AT CULVERT INLET.)

- NORMAL POOL STORAGE CAPACITY = 30×10^6 GAL ≅ 92 ACRE-FEET (SEE NOTE 1)

- MAXIMUM POOL STORAGE CAPACITY = 132 AC-FT (HEC-1 OUTPUT) (@ LOW TOP OF DAM)

- DRAINAGE AREA ≅ 1.1 SQ. MI. (PLANIMETERED ON USGS TOPO QUADS, 7.5 MINUTE, ROME AND LE RAYSVILLE, PA)

ELEVATIONS:

TOP OF DAM (DESIGN) ≅	1213.0	(FIG. 3; SEE NOTE 2)
TOP OF DAM (FIELD) ≅	1213.3	
NORMAL POOL ≅	1212.0	(SEE NOTE 2)
UPSTREAM INLET INVERT (DESIGN) ≅	1206.0	(FIG. 4; SEE NOTE 2)
DOWNSTREAM OUTLET INVERT (DESIGN) ≅	1202.0	(FIG. 4; SEE NOTE 2)
DOWNSTREAM OUTLET INVERT (FIELD) ≅	1204.8	
STREAMBED @ DAM CENTERLINE ≅	NOT KNOWN	

NOTE 1: FOUND IN WATER RESOURCES INVENTORY FORM (CONTAINED IN PENN DER FILES), TOTEM LAKE DAM, BRADFORD COUNTY, PA.

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY DDS DATE 6-13-80 PROJ. NO. 79-203-042

CHKD. BY WJV DATE 7-31-80 SHEET NO. 2 OF 25

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NOTE 2: NORMAL POOL ELEVATION IS REPORTED AS 1212.0 ON THE USGS 7.5' TOPO QUADS FOR ROME AND LE RAYSVILLE, PA. THE ELEVATION OF THE BASE OF THE STOP-LOG, OR THE INVERT OF THE OVERFLOW STRUCTURE ITSELF, IS THEN 1211.0, AS MEASURED DURING THE FIELD SURVEY. IT IS NOTED ON THE DESIGN DRAWINGS (FIG. 4) THAT ALL ELEVATIONS ARE REFERENCED TO B.M. ELEV 94.0, LOCATED ON TOP OF THE OVERFLOW STRUCTURE. THEREFORE, THE ACTUAL ELEVATIONS ARE 1117.0 FT (1211.0 − 94.0) ABOVE THOSE GIVEN ON THE DESIGN DRAWINGS. (NOTE: THE ELEVATIONS USED IN THIS ANALYSIS ARE CONSIDERED ESTIMATES, AND ARE NOT NECESSARILY ACCURATE.)

DAM CLASSIFICATION

DAM SIZE:	SMALL	(REF 1, TABLE 1)
HAZARD CLASSIFICATION:	HIGH	(FIELD OBSERVATION)
REQUIRED SDF:	½ PMF TO PMF	(REF 1, TABLE 3)

HYDROGRAPH PARAMETERS

- LENGTH OF LONGEST WATERCOURSE: $L = 1.8$ MI.
- LENGTH OF LONGEST WATERCOURSE FROM DAM TO A POINT OPPOSITE BASIN CENTROID: $L_{CA} \doteq 0.8$ MI.

(MEASURED ON USGS TOPO QUADS: ROME, AND LE RAYSVILLE, PA.)

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$C_t = 1.50$
$C_p \simeq 0.62$

(PROVIDED BY C.O.E., ZONE 11, SUSQUEHANNA RIVER BASIN.)

SNYDER'S STANDARD LAG:

$$t_p = C_t (L \cdot L_{CA})^{0.3}$$
$$\simeq 1.5 (1.8 \times 0.8)^{0.3}$$
$$= \underline{1.67} \text{ HOURS}$$

(NOTE: HYDROGRAPH VARIABLES USED HERE ARE DEFINED IN REF. 2, IN SECTION ENTITLED "SNYDER SYNTHETIC UNIT HYDROGRAPH.")

RESERVOIR CAPACITY

RESERVOIR SURFACE AREAS:

- S.A. @ ELEV. 1212.0 (NORMAL POOL) ≃ 30 ACRES
- S.A. @ ELEV. 1220.0 ≃ 44 ACRES

(PLANIMETERED ON USGS TOPO QUADS, ROME, AND LE RAYSVILLE, PA)

- LOW TOP OF DAM ELEVATION ≃ 1213.3 (FIELD NOTES)

BY LINEAR INTERPOLATION, S.A. @ ELEV. 1213.3 ≃ 32.3 ACRES

RESERVOIR ELEVATION @ "ZERO-STORAGE VOLUME":

USING THE CONIC METHOD,

VOL. @ NORMAL POOL ≃ 92 AC-FT ≃ $\frac{1}{3}$ HA

WHERE H = MAXIMUM DEPTH,

A = SURFACE AREA @ NORMAL POOL ≃ 30 ACRES.

SUBJECT DAM SAFETY INSPECTION

TOTEM LAKE DAM

BY DJS DATE 6-13-80 PROJ. NO. 79-203-042

CHKD. BY WJV DATE 7-31-90 SHEET NO. 4 OF 25

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$$\therefore \quad H \simeq \frac{3 \times 92}{30}$$

$$H \simeq \underline{9.2} \text{ FT}$$

$\therefore$ ZERO-STORAGE ELEVATION $\simeq 1212.0 - 9.2 \simeq \underline{1202.8}$

NOTE: ALTHOUGH THE ACTUAL MINIMUM RESERVOIR ELEVATION IS ESTIMATED TO BE AT ELEVATION 1203.0 (SEE FIG. 2 AND NOTE 2), THE VALUE CALCULATED ABOVE MUST BE USED IN THE HEC-1 PROGRAM IN ORDER TO MAINTAIN A STORAGE VALUE OF 92 ACRE-FEET AT NORMAL POOL.

ELEVATION-STORAGE RELATIONSHIP

AN ELEVATION-STORAGE RELATIONSHIP IS COMPUTED INTERNALLY IN THE HEC-1 PROGRAM, BY USE OF THE CONIC METHOD, BASED ON THE GIVEN RESERVOIR SURFACE AREA AND ELEVATION DATA. (SEE SUMMARY INPUT/OUTPUT SHEETS.)

SUBJECT	DAM SAFETY INSPECTION				
	TOTEM LAKE DAM				
BY	DJS	DATE	6-13-80	PROJ. NO.	79-303-042
CHKD. BY	WJV	DATE	7-31-80	SHEET NO.	5 OF 25

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PMP CALCULATIONS

- FROM REF. 9, FIG. 2, OBTAIN PMP VALUE FOR A BASIN OF DRAINAGE AREA 200 SQUARE MILES, AND FOR A DURATION OF 24 HOURS:

$$P = \underline{22.2} \text{ INCHES}$$

- FROM REF 9, FIG. 1, THE GEOGRAPHIC ADJUSTMENT FACTOR = 96 %.

- AREA CORRECTION FACTOR (REF. 9):

DURATION (HRS):	6	12	24	48	72
FACTOR (%):	117.5	127	136	142.5	145

- TOTAL CORRECTION FACTOR (0.96 x AREA CORRECTION FACTOR):

DURATION (HRS):	6	12	24	48	72
FACTOR (%):	113	122	131	137	139

- HOP BROOK FACTOR (ADJUSTMENT FOR BASIN SHAPE AND FOR THE LESSER LIKELIHOOD OF A SEVERE STORM CENTERING OVER A SMALL BASIN) FOR A DRAINAGE AREA OF 1.0 SQUARE MILE IS 0.80.

(REF 4, p. 48)

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY DJS DATE 6-18-80 PROJ. NO. 79-203-042

CHKD. BY WJV DATE 7-31-80 SHEET NO. 6 OF 25

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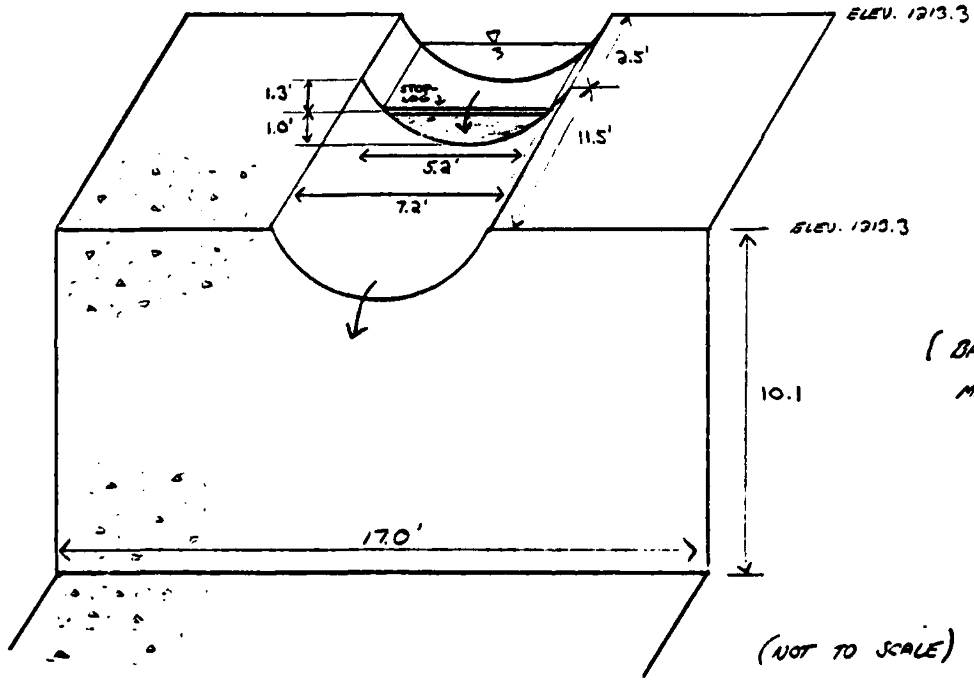
SPILLWAY CAPACITY



(BASED ON FIELD MEASUREMENTS)

(NOT TO SCALE)

THE SPILLWAY CONSISTS OF A FREE OVERFALL STRUCTURE WITH DISCHARGES REGULATED BY A WOODEN STOP-LOG, AS SHOWN ABOVE. SINCE THE STRUCTURE IS SMALL RELATIVE TO EXPECTED PMF-SIZE DISCHARGES, AND FOR SIMPLICITY, IT WILL BE ASSUMED THAT OUTFLOW WILL BE CONTROLLED BY CRITICAL FLOW. THUS, DISCHARGE CAN BE ESTIMATED BY THE EQUATION

$$Q = 3.087 L H^{3/2} ,$$ (REF 5, p. 5-24)

SUBJECT DAM SAFETY INSPECTION

TOTEM LAKE DAM

BY DJS DATE 6-18-80 PROJ. NO. 79-203-042

CHKD. BY WJV DATE 7-31-80 SHEET NO. 7 OF 25

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WHERE Q = DISCHARGE, IN CFS,
L = WEIR LENGTH, IN FT,
H = HEAD, IN FT.

IT CAN BE SEEN FROM THE SKETCH ON SHEET 6 THAT NOT ALL OF THE SPILLWAY DISCHARGE PASSES DIRECTLY OVER THE STOP-LOG WEIR. HOWEVER, IT WILL BE ASSUMED THAT THE DISCHARGE VELOCITY IS UNIFORM ACROSS THE ENTIRE SPILLWAY CROSS-SECTION, SO THAT AN AREA-CORRECTION FACTOR MAY BE APPLIED TO THE EQUATION GIVEN ON SHEET 6:

$$V_T = V_S$$

$$\frac{Q_T}{A_T} = \frac{Q_S}{A_S}$$

$$\therefore \quad Q_T = Q_S\left(\frac{A_T}{A_S}\right)$$

WHERE Q_T, V_T, A_T REFER TO TOTAL SPILLWAY DISCHARGE, VELOCITY, AND FLOW AREA, RESPECTIVELY, AND Q_S, V_S, A_S REFER TO DISCHARGE, VELOCITY, AND FLOW AREA OVER STOP-LOG WEIR.

THE AREA BETWEEN THE TOP OF THE STOP-LOG (ELEV. 1212.0) AND THE TOP OF THE DAM (ELEV. 1213.3) IS ASSUMED TO BE APPROXIMATELY TRAPEZOIDAL IN SHAPE.

THUS, THE AREA ABOVE TOP OF FLASHBOARDS TO A HEIGHT = 1.3 FT (TOP OF DAM, EL. 1213.3)

$$A_T = (1.3)\left[(7.2 + 5.2)/2\right] \simeq \underline{8.1} \text{ FT}^2$$

AND THAT CORRESPONDING TO A HEIGHT = 1.0 (EL. 1213.0)

$$A_T = (1.0)\left\{\left[\left(\left[\tfrac{1.0}{1.3} \times 2.0\right] + 5.2\right) + 5.2\right]/2\right\} = \underline{6.0}$$

ABOVE ELEVATION 1213.3,

$$A_T = 8.1 + \left[7.2 \times (\text{RESERVOIR ELEVATION} - 1213.3)\right]$$

SUBJECT DAM SAFETY INSPECTION

TOTEM LAKE DAM

BY DJS DATE 6-18-80 PROJ. NO. 79-203-042

CHKD. BY WJV DATE 7-31-80 SHEET NO. 8 OF 25

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SPILLWAY RATING TABLE:

	RESERVOIR ELEVATION (FT)	H (FT)	① Q_S (CFS)	② A_S (FT^2)	③ A_T (FT^2)	④ Q_T (CFS)
	1212.0	—	0	—	—	0
	1213.0	1.0	16	5.2	6.0	20
(TOP OF DAM)	1213.3	1.3	24	6.8	8.1	30
	1213.8	1.8	39	9.4	11.7	50
	1214.3	2.3	56	12.0	15.3	70
	1214.8	2.8	75	14.6	18.9	100
	1215.3	3.3	96	17.2	22.5	130
	1215.8	3.8	119	19.8	26.1	160
	1216.3	4.3	143	22.4	29.7	190
	1216.8	4.8	169	25.0	33.3	230
	1217.3	5.3	196	27.6	36.9	260

① $Q_S \simeq (3.087)(5.2)H^{3/2}$

② $A_S = 5.2 \times H$

③ FROM SHEET 7.

④ $Q_T \simeq Q_S (A_T/A_S)$ → ROUNDED TO NEAREST 10 CFS.

APPROACH CHANNEL LOSSES ASSUMED NEGLIGIBLE.

UBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY DJS DATE 6-23-80 PROJ. NO. 79-203-042

CHKD. BY WJV DATE 7-31-80 SHEET NO. 9 OF 25

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EMBANKMENT RATING TABLE

ASSUME THAT THE EMBANKMENT BEHAVES ESSENTIALLY AS A BROAD-CRESTED WEIR WHEN OVERTOPPING OCCURS. THUS, THE DISCHARGE CAN BE ESTIMATED BY THE RELATIONSHIP

$$Q = CLH^{3/2}$$ (REF 5, p. 5-23)

WHERE
Q = DISCHARGE OVER EMBANKMENT, IN CFS,
L = LENGTH OF EMBANKMENT OVERTOPPED, IN FT,
H = HEAD, IN FT; IN THIS CASE, IT IS THE AVERAGE "FLOW AREA WEIGHTED" HEAD ABOVE THE CREST;
C = COEFFICIENT OF DISCHARGE.

LENGTH OF EMBANKMENT INUNDATED VS. RESERVOIR ELEVATION:

RESERVOIR ELEVATION (FT)	EMBANKMENT LENGTH (FT)
1213.30	0
1213.31	150
1213.8	160
1214.3	175
1214.8	195
1215.3	215
1215.8	235
1216.3	255
1216.8	270
1217.3	290

(FROM FIELD MEASUREMENTS, FIG. 2, AND USGS TOPO QUAD: LE RAYSVILLE, PA)

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY DJS DATE 6-23-80 PROJ. NO. 79-203-042
CHKD. BY WJV DATE 7-31-80 SHEET NO. 10 OF 25

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ASSUME THAT INCREMENTAL DISCHARGES OVER THE EMBANKMENT FOR SUCCESSIVE RESERVOIR ELEVATIONS ARE APPROXIMATELY TRAPEZOIDAL IN CROSS-SECTIONAL FLOW AREA. THEN ANY INCREMENTAL AREA OF FLOW CAN BE ESTIMATED AS $H_i [(L_1+L_2)/2]$, WHERE L_1 = LENGTH OF EMBANKMENT OVERTOPPED AT HIGHER ELEVATION, L_2 = LENGTH AT LOWER ELEVATION, H_i = DIFFERENCE IN ELEVATIONS. THUS, THE TOTAL AVERAGE FLOW-AREA WEIGHTED HEAD CAN BE ESTIMATED AS H_w = (TOTAL FLOW AREA / L_1).

EMBANKMENT RATING TABLE*

RESERVOIR ELEVATION (FT)	L_1 (FT)	L_2 (FT)	INCREMENTAL HEAD, H_i (FT)	① INCREMENTAL FLOW AREA, A_i (FT²)	TOTAL FLOW AREA, A_T (FT²)	② WEIGHTED HEAD, H_w (FT)	③ H_w / ℓ	④ C	⑤ Q (CFS)
1213.30	0	–	–	–	–	–	–	–	0
1213.31	150	0	–	–	–	–	–	–	0
1213.8	160	150	0.5	78	78	0.5	0.13	3.02	170
1214.3	175	160	0.5	84	162	0.9	0.23	3.08	460
1214.8	195	175	0.5	93	255	1.3	0.33	3.09	890
1215.3	215	195	0.5	103	358	1.7	0.43	3.09	1470
1215.8	235	215	0.5	113	471	2.0	0.50	3.09	2050
1216.3	255	235	0.5	123	594	2.3	0.58	3.09	2750
1216.8	270	255	0.5	131	725	2.7	0.68	3.09	3700
1217.3	290	270	0.5	140	865	3.0	0.75	3.09	4660

① $A_i = H_i \left[\frac{L_1+L_2}{2}\right]$

② $H_w = A_T / L_1$

③ ℓ = BREADTH OF CREST = 4 FT (WIDTH OF CONCRETE)

④ $C = f(H_w, \ell)$; FROM REF 12, FIG. 24.

⑤ $Q = C L_1 H_w^{3/2}$

* SEE SHEET 13.

UBJECT DAM SAFETY INSPECTION

TOTEM LAKE DAM

BY DJS DATE 6-23-80 PROJ. NO. 79-203-042

CHKD. BY WJV DATE 7-31-80 SHEET NO. 11 OF 25

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TOTAL FACILITY RATING CURVE

$Q_{TOTAL} \simeq Q_{SPILLWAY} + Q_{EMBANKMENT}$

	ELEVATION (FT)	① Q SPILLWAY (CFS)	② Q EMBANKMENT (CFS)	Q TOTAL (CFS)
	1212.0	0	–	0
	1213.0	20	–	20
(TOP OF DAM)	1213.3	30	0	30
	1213.8	50	170	220
	1214.3	70	460	530
	1214.8	100	890	990
	1215.3	130	1470	1600
	1215.8	160	2050	2210
	1216.3	190	2750	2940
	1216.8	230	3700	3930
	1217.3	260	4660	4920

① FROM SHEET 8

② FROM SHEET 10.

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY DJS DATE 6-24-80 PROJ. NO. 79-203-042
CHKD. BY WJV DATE 7-31-80 SHEET NO. 12 OF 25

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EMBANKMENT RATING CURVE - ROADWAY

ASSUME THAT THE ROADWAY JUST DOWNSTREAM FROM THE MAIN EMBANKMENT (SEE FIG. 2) ACTS ESSENTIALLY AS A BROAD-CRESTED WEIR WHEN OVERTOPPING OCCURS. THEN THE DISCHARGE OVER THE ROADWAY CAN BE ESTIMATED AS

$$Q = CLH^{3/2}$$ (SEE SHEET 9).

ROADWAY RATING TABLE*:

ELEVATION (FT)	① L_1 (FT)	L_2 (FT)	INCREMENTAL HEAD, H_i (FT)	② INCREMENTAL FLOW AREA, A_i (FT²)	TOTAL FLOW AREA, A_T (FT²)	③ WEIGHTED HEAD, H_w (FT)	④ H_w/ℓ	⑤ C	⑥ Q (CFS)
1310.9	0	—	0	—	—	—	—	—	0
1311.4	50	0	0.5	13	13	0.3	0.01	2.99	20
1311.9	85	50	0.5	34	47	0.6	0.02	3.03	130
1312.4	115	85	0.5	50	97	0.8	0.02	3.03	250
1312.9	145	115	0.5	65	162	1.1	0.03	3.04	510
1313.4	170	145	0.5	79	241	1.4	0.04	3.04	860
1313.9	185	170	0.5	89	330	1.8	0.05	3.04	1360
1314.4	205	185	0.5	98	428	2.1	0.06	3.05	1900
1314.9	250	205	0.5	114	542	2.2	0.06	3.05	2490
1315.4	275	250	0.5	131	673	2.4	0.07	3.05	3120
1315.9	285	275	0.5	140	813	2.9	0.08	3.05	4290

① L_1 = LENGTH OF EMBANKMENT OVERTOPPED; VALUES DETERMINED FROM FIELD SURVEY, FROM FIG. 2, AND FROM USGS TOPO QUAD, LERAYSVILLE, PA.

② $A_i = H_i [(L_1 + L_2)/2]$

③ $H_w = A_T / L_1$

④ ℓ = BREADTH OF CREST = 35' (FIELD NOTES)

⑤ $C = f(H_w, \ell)$; FROM REF 12, FIG. 24

⑥ $Q = C L_1 H_w^{3/2}$

* SEE SHEETS 9, 10 FOR ASSUMPTIONS & METHODOLOGY.

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM
BY DJS DATE 6-24-80 PROJ. NO. 79-203-042
CHKD. BY WJV DATE 7-31-80 SHEET NO. 13 OF 25

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CHECK FOR TAILWATER EFFECTS:

SINCE THE ELEVATION OF THE ROADWAY IS HIGH IN RELATION TO THE TOP OF THE DAM (TOP OF DAM = ELEV. 1213.3, LOW TOP OF ROAD = 1210.9), IT IS POSSIBLE THAT TAILWATER FROM THE ROADWAY DISCHARGE WILL AFFECT THE DISCHARGE OVER THE DAM ITSELF. IT WILL BE ASSUMED THAT THE RELATIONSHIPS GIVEN IN REF 4, pp. 376-382, FOR TAILWATER EFFECTS ON OGEE WEIR FLOW, CAN BE APPLIED HERE.

— AT ELEV. 1215.9, DISCHARGE OVER THE ROADWAY ≅ 4290 CFS;

FROM SHEET 11, 4290 CFS OVER THE DAM OCCURS APPROXIMATELY AT ELEVATION 1217.0.

$\therefore \; He = 1217.0 - 1213.3 = \underline{3.7}$ FT $= h_d + d$ { SEE REF 4, FIG. 254, p. 383

AND $d = 1215.9 - 1213.3 = \underline{2.6}$ FT

$\therefore \; h_d = He - d = 3.7 - 2.6 = \underline{1.1}$ FT

$$\frac{h_d}{He} = \frac{1.1}{3.7} = \underline{0.30}$$

FROM FIG. 254, REF. 4, $\frac{C_s}{C} = \underline{0.94}$, OR, IN OTHER WORDS, THE DISCHARGE OVER THE DAM WILL BE REDUCED BY ABOUT 6%. SINCE A REDUCTION OF ONLY 6% OCCURS UNDER EXTREME CONDITIONS, IT IS CONCLUDED THAT THE EFFECTS OF TAILWATER ARE MINOR, AND THUS, NO MODIFICATIONS ARE MADE TO THE TOTAL FACILITY RATING TABLE ON SHEET 11.

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY DJS DATE 6-24-80 PROJ. NO. 79-203-042
CHKD. BY WJV DATE 7-31-90 SHEET NO. 14 OF 25

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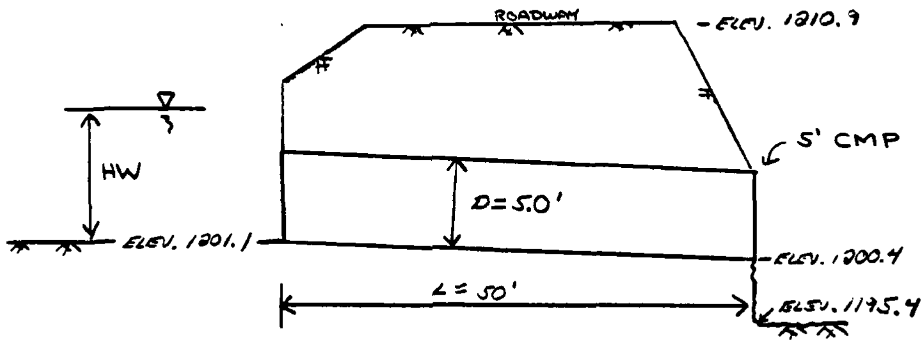
CULVERT CAPACITY

IMMEDIATELY DOWNSTREAM OF THE SPILLWAY THE DISCHARGE PASSES THROUGH A 5-FOOT DIAMETER CIRCULAR ROADWAY CULVERT (SEE FIG. 2). DISCHARGE THROUGH THE CULVERT IS CALCULATED UNDER INLET CONTROL AND OUTLET CONTROL:

I) INLET CONTROL:

PROFILE OF CULVERT:



DISCHARGES UNDER INLET CONTROL CONDITIONS FOR VARIOUS HEADWATER DEPTHS ARE TAKEN FROM REF 19, CHART 5: (W/HEADWALL + SQUARE-EDGED INLET)

	ELEVATION (FT)	HW (FT)	HW/D	Q (CFS)	ELEV (FT)	HW (FT)	HW/D	Q (CFS)
	1201.1	0	0	0	1212.4	11.3	2.3	280
	1203.6	2.5	0.5	40	1212.9	11.8	2.4	285
	1206.1	5.0	1.0	130	1213.4	12.3	2.5	295
	1208.0	6.9	1.4	190	1213.9	12.8	2.6	300
	1210.0	8.9	1.8	240	1214.4	13.3	2.7	305
(TOP OF ROAD)	1210.9	9.8	2.0	250	1214.9	13.8	2.8	310
	1211.4	10.3	2.1	260	1215.4	14.3	2.9	325
	1211.9	10.8	2.2	270	1215.9	14.8	3.0	340

SUBJECT DAM SAFETY INSPECTION

TOTEM LAKE DAM

BY DJS DATE 6-24-80 PROJ. NO. 79-277-042

CHKD. BY WJV DATE 7-31-80 SHEET NO. 15 OF 25

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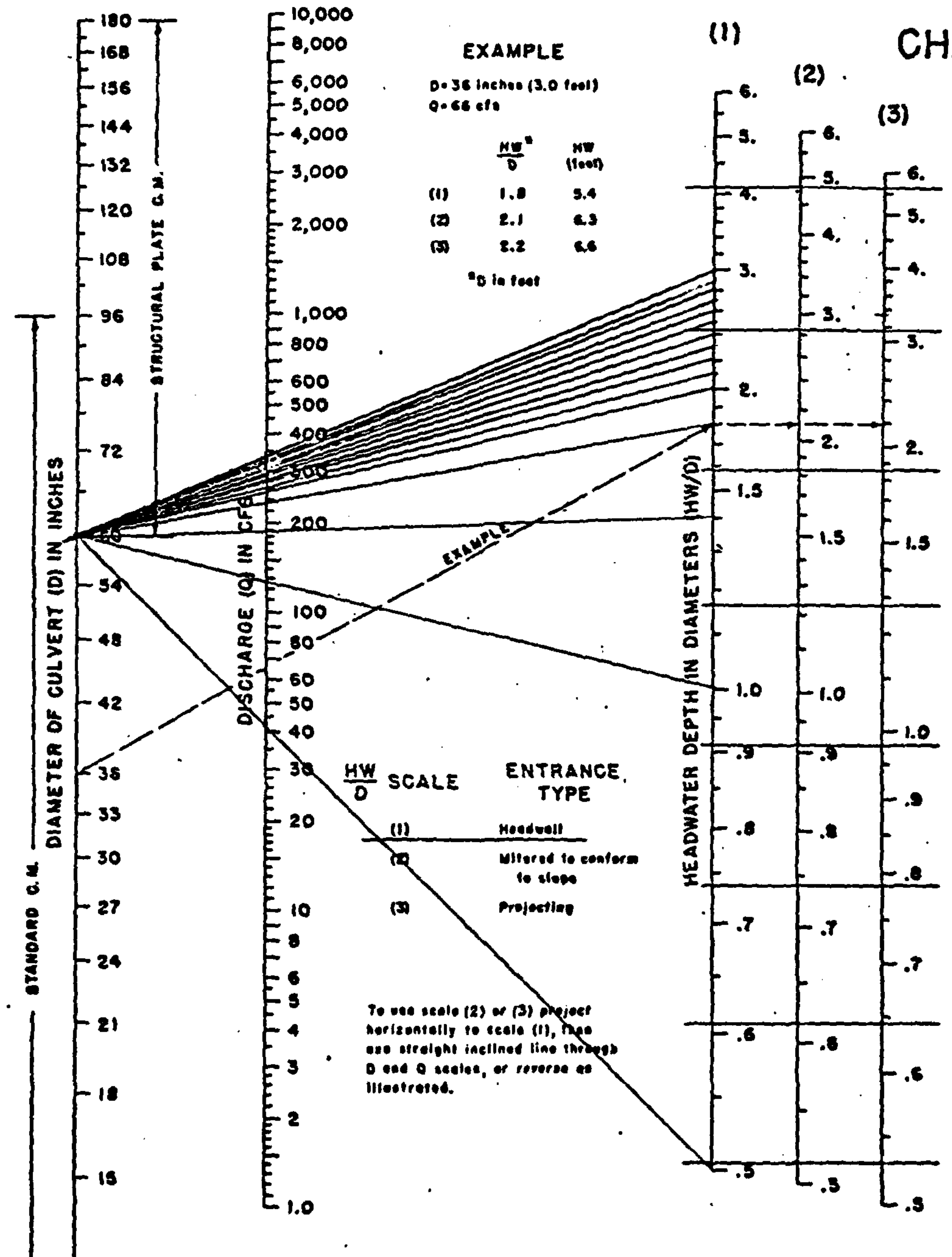
CHART 5



HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

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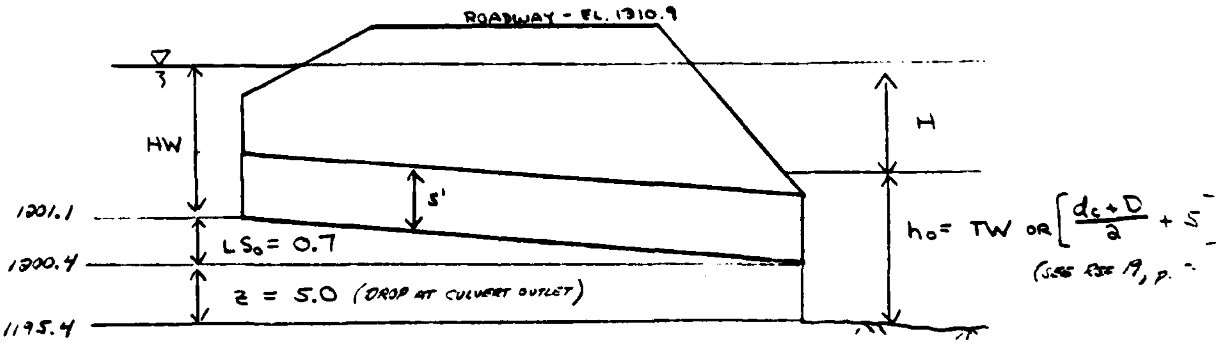
II) OUTLET CONTROL :

ASSUMING THAT THE CULVERT FLOWS UNDER OUTLET CONTROL, THE HEADWATER DEPTH CAN BE EXPRESSED AS

$$HW = H + h_o - L S_o - z \qquad \text{(REF 19, p. 5-9)}$$

WHERE
- HW = HEADWATER DEPTH, IN FT,
- H = HEAD OR ENERGY REQUIRED TO PASS A GIVEN FLOW, IN FT,
- h_o = STAGE OF HYDRAULIC GRADE LINE (HGL) OR EQUIVALENT HGL AT OUTLET (SEE REF 19, pp. 5-8 — 5-1…
- L = LENGTH OF CULVERT ≅ 50 FT,
- S_o = SLOPE OF CULVERT ≅ 0.014 FT/FT.

$\left.\begin{matrix}\\ \\ \end{matrix}\right\}$ {FIELD MEASUREMENTS}



ALSO, ASSUME THAT

$$H = H_V + H_E + H_F \qquad \text{(REF 19, p. 5-5)}$$

WHERE
- H_V = VELOCITY HEAD, IN FT,
- H_E = ENTRANCE LOSS, IN FT, AND
- H_F = FRICTION LOSS IN CULVERT, IN FT.

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$H_V = \frac{V_c^2}{2g}$, WHERE V_c = VELOCITY IN CULVERT IN FPS;

$H_E = 0.5 \frac{V_c^2}{2g}$, WHERE LOSS COEFFICIENT = 0.5 (REF 19, p. 5-49);
(HEADWALL + SQUARE-EDGED INLET)

$H_F = \left[\frac{2gn^2L}{R^{4/3}}\right]\frac{V_c^2}{2g}$

WHERE n = MANNING'S ROUGHNESS FACTOR = 0.024 (REF 19, p. 5-30,
R = HYDRAULIC RADIUS = A/P_w, IN FT,
A = CULVERT AREA, IN FT^2,
P_w = WETTED PERIMETER OF CULVERT, IN FT.

— UNDER FULL-FLOW CONDITIONS,

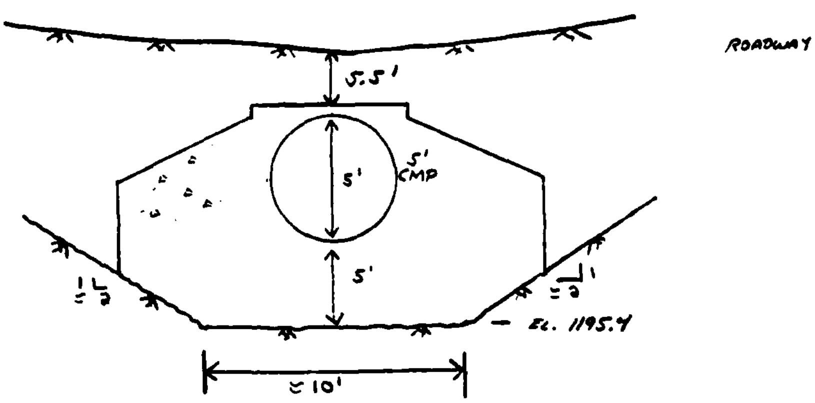
$A = \frac{\pi D^2}{4} = \frac{\pi 5^2}{4} = 19.6\ FT^2$

$P_w = \pi D = 5\pi = 15.7\ FT$

$\therefore\ R = \frac{A}{P_w} = \frac{19.6}{15.7} = \underline{1.2}\ FT$

⟶ FOR CHANNEL SECTION JUST DOWNSTREAM OF CULVERT, ESTIMATE TAILWATER DEPTHS FOR VARIOUS DISCHARGES:

CHANNEL SECTION:



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USE MANNING'S EQUATION TO ESTIMATE TAILWATER DEPTHS. ASSUME CHANNEL SLOPE ≈ 0.08 (USGS TOPO QUAD - LE RAYSVILLE, PA), AND MANNING'S ROUGHNESS COEFFICIENT ≈ 0.065 (REF. 18, ESTIMATE).

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2} \qquad \text{(REF 5, p.7-14).}$$

WHERE Q = DISCHARGE, IN CFS,
n = ROUGHNESS COEFFICIENT ≈ 0.065,
A = FLOW AREA ≈ $10y + 2y^2$
R = HYDRAULIC RADIUS = A/P_w = $A/(10 + 4.5y)$
S = CHANNEL SLOPE ≈ 0.08

TAILWATER DEPTHS:

AT $y = 5$, $Q = \left(\frac{1.49}{0.065}\right)(100)\left(\frac{100}{32.5}\right)^{2/3}\sqrt{0.08} \approx$ 1370 CFS
AT $y = 6$, $Q = \left(\frac{1.49}{0.065}\right)(132)\left(\frac{132}{37}\right)^{2/3}\sqrt{0.08} \approx$ 2000 CFS
AT $y = 7$, $Q = \left(\frac{1.49}{0.065}\right)(168)\left(\frac{168}{41.5}\right)^{2/3}\sqrt{0.08} \approx$ 2770 CFS
AT $y = 8$, $Q = \left(\frac{1.49}{0.065}\right)(208)\left(\frac{208}{46}\right)^{2/3}\sqrt{0.08} \approx$ 3690 CFS
AT $y = 9$, $Q = \left(\frac{1.49}{0.065}\right)(252)\left(\frac{252}{50.5}\right)^{2/3}\sqrt{0.08} \approx$ 4770 CFS
AT $y = 10$, $Q = \left(\frac{1.49}{0.065}\right)(300)\left(\frac{300}{55}\right)^{2/3}\sqrt{0.08} \approx$ 6030 CFS

COMPUTE INITIAL RATING TABLE FOR CULVERT:

$$HW = H + h_o - LS_o - Z$$

WHERE Z = 5.0 FT,
$LS_o \approx$ 0.7 FT,

$$H = H_v + H_e + H_f$$
$$= \left[1.0 + 0.5 + \frac{29 n^2 L}{R^{4/3}}\right]\frac{V_c^2}{2g}$$
$$\approx \left[1.0 + 0.5 + \frac{29(0.024)^2(50)}{(1.2)^{4/3}}\right]\frac{V_c^2}{2g}$$
$$\approx 2.16\frac{V_c^2}{2g}$$

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RATING TABLE:

Q (CFS)	V_c ① (FT/SEC)	H ② (FT)	TW ③ (FT)	d_c ④ (FT)	$\frac{d_c+D}{2}$ (FT)	h_o ⑤ (FT)	HW ⑥ (FT)	ELEV. ⑦ (FT)
200	10.2	3.5	—	4.1	4.6	9.6	7.4	1208.5
300	15.3	7.9	—	4.8	4.9	9.9	12.1	1213.2
340	17.3	10.0	—	≈5.0	≈5.0	≈10.0	14.3	1215.4

→ @ ELEV. 1215.4, Q ≈ 340 CFS. HOWEVER, AT THE SAME ELEVATION, AND ASSUMING INLET CONTROL, Q ≈ 325 CFS. THEREFORE, AT THIS ELEVATION, THE FLOW WILL BE DICTATED BY INLET CONTROL. FOR THE ENTIRE RANGE OF DISCHARGES AND ELEVATIONS USED IN THIS ANALYSIS, THEN, ALL CULVERT FLOW WILL BE DICTATED BY INLET CONTROL.

(NOTE: AT ELEV. 1215.4, DISCHARGE OVER THE ROADWAY IS APPROXIMATELY 3120 CFS (SHEET 12). THIS CORRESPONDS TO A TAILWATER ELEVATION OF ABOUT 7.4 FT (SHEET 18). HOWEVER, THIS IS AT AN ELEVATION (1195.4 + 7.4 = 1202.8) LESS THAN THAT OF THE EQUIVALENT HYDRAULIC GRADE LINE COMPUTED ABOVE (1195.4 + 5.0 + 5.0 = 1205.4), AND THUS, WILL HAVE NO EFFECT ON THE ABOVE CALCULATIONS.)

---

① $V_c = \frac{Q}{A} = \frac{Q}{19.6}$

② $H = 2.16\ V_c^2/2g$

③ TW = TAILWATER ELEVATION, FROM SHEET 16; FOR THE DISCHARGES USED HERE, THE TAILWATER IS WELL BELOW THE INVERT OF THE CULVERT OUTLET.

④ d_c = CRITICAL DEPTH AT CULVERT OUTLET; FROM REF 19, CHART 16.

⑤ $h_o = TW$ OR $\left[\frac{d_c+D}{2}+5\right]$, THE GREATER OF THE TWO VALUES.

⑥ $HW = H + h_o - 5.7$

⑦ $ELEV = HW + 1201.1$

SUBJECT DAM SAFETY INSPECTION

TOTEM LAKE DAM

BY JJS DATE 6-25-80 PROJ. NO. 79-203-042

CHKD. BY WJV DATE 7-31-80 SHEET NO. 20 OF 25

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TOTAL RATING CURVE - ROADWAY

	ELEVATION (FT)	① $Q_{CULVERT}$ (CFS)	② $Q_{ROADWAY}$ (CFS)	③ Q_{TOTAL} (CFS)
	1201.1	0	-	0
	1203.6	40	-	40
	1206.1	130	-	130
	1208.0	190	-	190
	1210.0	240	-	240
(TOP OF ROAD)	1210.9	250	0	250
	1211.4	260	20	280
	1211.9	270	120	390
	1212.4	280	250	530
	1212.9	285	510	800
	1213.4	295	860	1160
	1213.9	300	1360	1660
	1214.4	305	1900	2210
	1214.9	310	2490	2800
	1215.4	325	3120	3450
	1215.9	340	4290	4630

① FROM SHEET 14.

② FROM SHEET 12.

③ $Q_{TOTAL} = Q_{CULVERT} + Q_{ROADWAY}$ (ROUNDED TO NEAREST 10 CFS).

SUBJECT DAM SAFETY INSPECTION

TOTEM LAKE DAM

BY DJS DATE 6-25-80 PROJ. NO. 79-203-042

CHKD. BY NJV DATE 7-31-80 SHEET NO. 21 OF 25

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IN ORDER TO INCLUDE THE ROADWAY EMBANKMENT AS PART OF THE ANALYSIS, STORAGE BEHIND THE EMBANKMENT MUST BE TAKEN INTO ACCOUNT. ALTHOUGH THE STORAGE AVAILABLE BEHIND THE EMBANKMENT IS ESSENTIALLY NEGLIGIBLE, IT MUST BE INCLUDED AS PART OF THE INPUT DATA FOR THE HEC-1 COMPUTER PROGRAM.

AN ELEVATION-STORAGE RELATIONSHIP IS COMPUTED INTERNALLY IN THE HEC-1 PROGRAM, BASED ON THE SURFACE AREA-ELEVATION DATA GIVEN HERE:

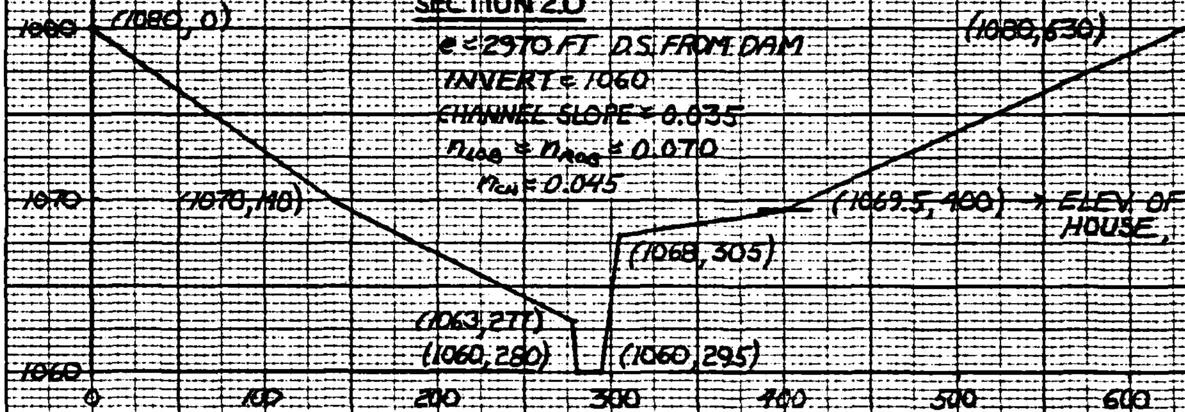
	ELEVATION (FT)	SURFACE AREA (AC)	
	1201.1	0	
	1203.2	0.02	
(TOP OF ROAD)	1210.9	0.02	(BASED ON FIELD SURVEY AND FIG. 2)
	1216.0	0.5	

SUBJECT Totem Lake Dam
BY ZJS DATE 7-7-80 SHEET NO. 22 OF 26
CHKD. BY WJV DATE 7-31-80 PROJECT NO. 79-203-042

DOWNSTREAM ROUTING SECTIONS

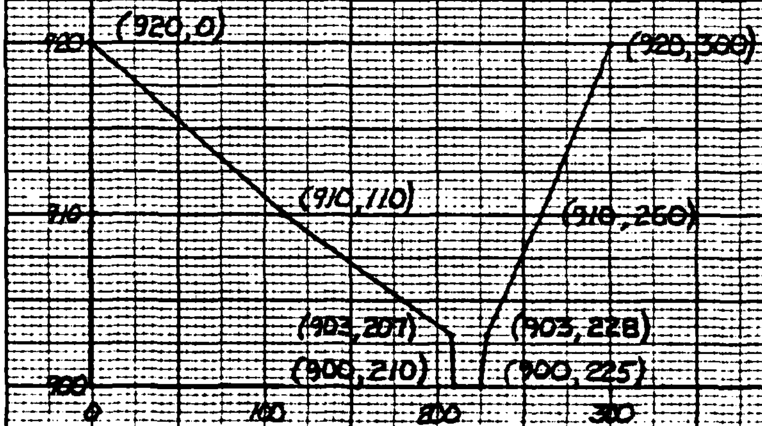
SECTION 2.0

℄ ≈ 2970 FT. D.S. FROM DAM
INVERT ≈ 1060
CHANNEL SLOPE ≈ 0.035
$n_{LOB} \approx n_{ROB} \approx 0.070$
$n_{CH} \approx 0.045$



SECTION 3.0

℄ ≈ 9230 FT. D.S. FROM DAM
REACH LENGTH ≈ 6260 FT
INVERT ≈ 900
CHANNEL SLOPE ≈ 0.024
$n_{LOB} \approx 0.070$
$n_{ROB} \approx 0.100$
$n_{CH} \approx 0.045$

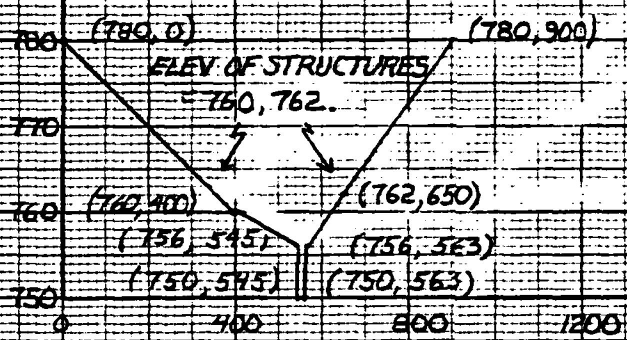


NOTE: SECTIONS BASED ON FIELD NOTES AND OBSERVATIONS AND USGS TOPO QUADS – LeRAYSVILLE AND LACEYVILLE, PA. ELEVATIONS ARE ESTIMATES OFF TOPO QUADS, AND ARE NOT NECESSARILY ACCURATE.

SUBJECT Totem Lake Dam
BY DJS DATE 7-7-80 SHEET NO. 23 OF 25
CHKD. BY WSV DATE 7-31-80 PROJECT NO. 79-203-043

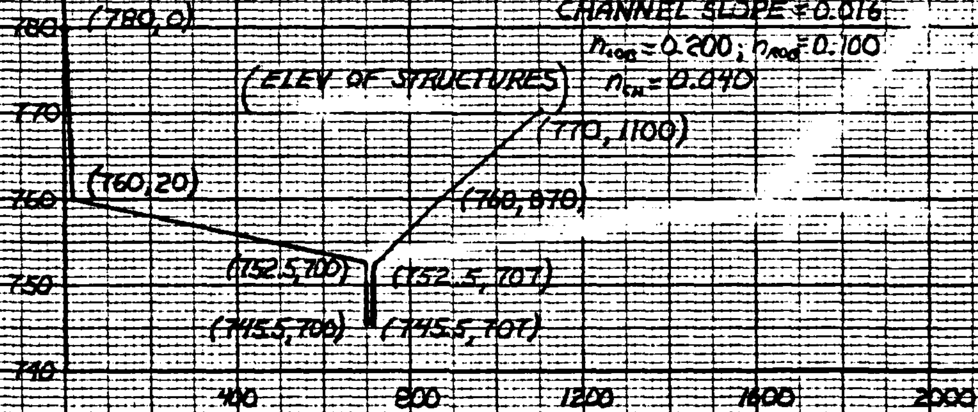
SECTION 4.0

℄ = 17,580 FT D.S. FROM DAM
REACH LENGTH = 8350 FT
INVERT = 750
CHANNEL SLOPE = 0.016
$n_{LOB} = n_{ROB} = 0.080$
$n_{CH} = 0.040$



SECTION 5.0

℄ = 17,880 FT DS. FROM DAM
REACH LENGTH = 300 FT (FIELD MEASURED)
INVERT = 745.5
CHANNEL SLOPE = 0.016
$n_{LOB} = 0.200$; $n_{ROB} = 0.100$
$n_{CH} = 0.040$



SUBJECT DAM SAFETY INSPECTION

TOTEM LAKE DAM

BY ZJS DATE 7-29-80 PROJ. NO. 79-203-042

CHKD. BY WJV DATE 7-30-80 SHEET NO. 24 OF 25

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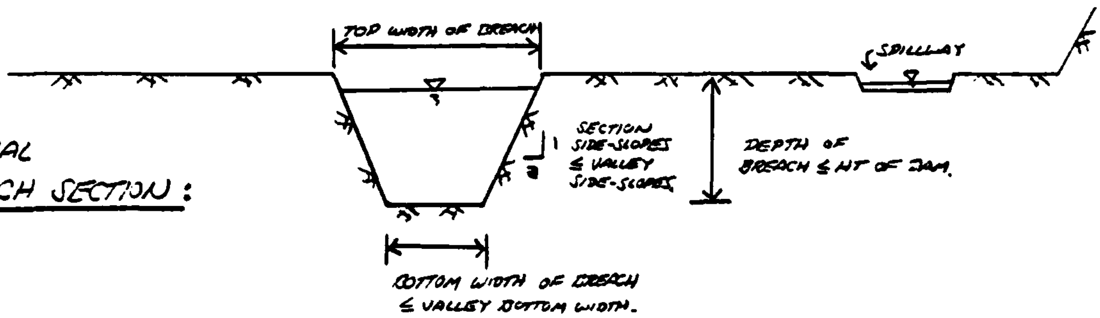
BREACH ASSUMPTIONS:

TYPICAL BREACH SECTION:



HEC-1 DAM BREACHING ANALYSIS INPUT: THE PORTION OF THE DAM WHICH WOULD MOST LIKELY FAIL DUE TO OVERTOPPING IS THE AREA AROUND THE SPILLWAY STRUCTURE (DUE TO THE EROSION AND COLLAPSE OF THE ROCK WALLS LINING THE SPILLWAY - SEE PHOTOGRAPHS 5, 6). LIKEWISE, THE ROADWAY EMBANKMENT IS MOST LIKELY TO FAIL AROUND THE CULVERT.

BREACH DIMENSIONS:

MAIN DAM: BOTTOM WIDTH OF BREACH SECTION = 17 FT (U.S. WIDTH OF SPILLWAY CHANNEL - SHEET

DEPTH = 10.1 FT (HEIGHT OF SPILLWAY STRUCTURE - SHEET 6)

SIDE-SLOPES = 1H : 1V (ASSUMED SLOPES)

FAILURE TIME = 1/2 HOUR, 4 HOURS

ROADWAY EMBANKMENT:

DUE TO THE EXTREMELY SMALL STORAGE CAPACITY BEHIND THE ROADWAY EMBANKMENT, IT IS BEYOND THE CAPABILITIES OF THE HEC-1 PROGRAM TO MODEL THE ROADWAY EMBANKMENT BREACH IN COMBINATION WITH THE BREACHING OF THE MAIN DAM. THEREFORE, IT IS ASSUMED THAT THE ROADWAY HAS BREACHED SIGNIFICANTLY PRIOR TO THE BREACHING OF THE MAIN DAM, OR, ERODES AT THE SAME RATE, AND THUS, THE ROADWAY EMBANKMENT WILL BE IGNORED IN THE BREACHING ANALYSIS.

→ THE BREACH ANALYSIS WILL BE RUN UNDER 0.15 PMF BASE FLOOD CONDITIONS, SINCE IT IS ESTIMATED THAT THIS FLOW WILL REMAIN JUST WITHIN BANK IN THE D.S. COMMUNITY.

SUBJECT DAM SAFETY INSPECTION

TOTEM LAKE DAM

BY DJS DATE 7-30-80 PROJ. NO. 79-203-042

CHKD. BY WJV DATE 7-30-80 SHEET NO. 25 OF 25

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HEC-1 DAM BREACHING ANALYSIS OUTPUT

RESERVOIR DATA: (UNDER 0.15 PMF BASE FLOW CONDITIONS)

PLAN NUMBER / FAILURE TIME	ACTUAL MAX. FLOW DURING FAIL TIME (CFS)	CORRESPONDING TIME OF PEAK (HRS)	INTERPOLATED OR HEC-1 ROUTED MAX. FLOW DURING FAIL TIME (CFS)	CORRESPONDING TIME OF PEAK (HRS)	ACTUAL PEAK FLOW THROUGH DAM (CFS)	CORRESPONDING TIME OF PEAK (HRS)	TIME OF INITIAL BREACH (HRS)
① → 0.5 HRS	2353	41.33	2353	41.33	2353	41.33	40.83
② → 4.0 HRS	941	44.00	941	44.00	941	44.00	43.83

NOTE: THE 0.15PMF NON-BREACH PEAK OUTFLOW IS ESTIMATED AS ≈ 380 CFS.

DOWNSTREAM ROUTING DATA: (UNDER 0.15 PMF BASE FLOW CONDITIONS)

PLAN NUMBER/ FAILURE TIME	PEAK FLOW (CFS)	CORRESPONDING WATER SURFACE ELEVATION ① (FT)	WATER SURFACE ELEVATION w/o BREACH ② (FT)	ELEVATION DIFFERENCE (FT)
OUTPUT @ SECTION 4.0; 17580 FT D.S. FROM DAM:				
① → 0.5 HRS	1682	757.1	752.6	+4.5
② → 4.0 HRS	928	755.0	752.6	+2.4
OUTPUT @ SECTION 5.0; 17880 FT D.S. FROM DAM:				
① → 0.5 HRS	1692	755.7	751.9	+3.8
② → 4.0 HRS	928	754.6	751.9	+2.7

① FROM SUMMARY INPUT/OUTPUT SHEETS, SHEET O.

② INTERPOLATED FROM RATING TABLES, SUMMARY INPUT/OUTPUT SHEETS, SHEETS G, H; BASED ON ESTIMATED 0.15PMF NON-BREACH PEAK OUTFLOW ≈ 360 CFS.

NOTE: DAMAGE LEVELS OF STRUCTURES @ SECTION 4.0 ≈ 760-762 FT.
DAMAGE LEVELS OF STRUCTURES @ SECTION 5.0 AT TOP OF BANKS, ≈ 752.5 FT.

SUBJECT: DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY: WJV DATE: 7-30-80 PROJ. NO. 79-203-042

CHKD. BY: [illegible] DATE: 7-30-80 SHEET NO. A OF O

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SUMMARY INPUT/OUTPUT SHEETS

OVERTOPPING ANALYSIS

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DAM SAFETY INSPECTION
TOTEM LAKE DAM AND DOWNSTREAM ROADWAY EMBANKMENT; OVERTOPPING ANALYSIS
10-MINUTE TIME STEP AND 48-HOUR STORM DURATION

                              JOB SPECIFICATION
  NO     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
 288       0      10       0       0       0       0       0       0       0
                        JOPER     NWT   LROPT   TRACE
                            5       0       0       0

                     MULTI-PLAN ANALYSES TO BE PERFORMED
                        NPLAN= 1 NRTIO= 3 LRTIO= 1
  RTIOS=    .05     .50    1.00

**********        **********        **********        **********        **********

                         SUB-AREA RUNOFF COMPUTATION

 RESERVOIR INFLOW

            ISTAQ   ICOMP    IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
             DAM        0        0       0       0       0       1       0       0

                              HYDROGRAPH DATA
 IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
     1      1    1.10    0.00    1.10    0.00   0.000       0       1       0

                               PRECIP DATA
             SPFE     PMS      R6     R12     R24     R48     R72     R96
             0.00   22.20  113.00  122.00  131.00  137.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS  .800

                                 LOSS DATA
 LROPT  STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
     0   0.00    0.00    1.00    0.00    0.00    1.00    1.00     .05    0.00    0.00

                          UNIT HYDROGRAPH DATA
                       TP=  1.67     CP= .62     NTA=  0

                             RECESSION DATA
                   STRTQ=   -1.50    QRCSN=    -.05    RTIOR= 2.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=11.11 AND R= 9.51 INTERVALS

       UNIT HYDROGRAPH 57 END-OF-PERIOD ORDINATES, LAG=  1.68 HOURS, CP=  .62  VOL= 1.00
      8.      30.      61.      97.     136.     176.     213.     241.     259.     269.
    266.     249.     225.     202.     182.     164.     148.     133.     120.     108.
     97.      87.      78.      71.      64.      57.      52.      46.      42.      38.
     34.      30.      27.      25.      22.      20.      18.      16.      15.      13.
     12.      11.      10.       9.       8.       7.       6.       6.       5.       5.
      4.       4.       3.       3.       3.       2.       2.
```

INITIAL AND CONSTANT RAINFALL LOSSES AS PER COE

BASEFLOW PARAMETERS AS PER COE

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY WJV DATE 7-30-80 PROJ. NO. 79-203-042

CHKD. BY DJS DATE 7-30-80 SHEET NO. 8 OF ○

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END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.33	22.08	2.25	91975.
										(618.)(	561.)(	57.)(	2604.44)

RESERVOIR INFLOW HYDROGRAPHS

0.05 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	153.	100.	32.	16.	4595.
CMS	4.	3.	1.	0.	130.
INCHES		.84	1.08	1.08	1.08
MM		21.42	27.40	27.42	27.42
AC-FT		49.	63.	63.	63.
THOUS CU M		61.	78.	78.	78.

0.50 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1534.	997.	319.	160.	45951.
CMS	43.	28.	9.	5.	1301.
INCHES		8.43	10.79	10.79	10.79
MM		214.24	273.97	274.17	274.17
AC-FT		495.	632.	633.	633.
THOUS CU M		610.	780.	781.	781.

PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3067.	1995.	638.	319.	91901.
CMS	87.	56.	18.	9.	2602.
INCHES		16.87	21.57	21.59	21.59
MM		428.48	547.94	548.34	548.34
AC-FT		989.	1265.	1266.	1266.
THOUS CU M		1220.	1560.	1561.	1561.

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HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	92.	-1

STAGE	1212.00	1213.00	1213.30	1213.80	1214.30	1214.80	1215.30	1215.80	1216.30
	1217.30								
FLOW	0.00	20.00	30.00	220.00	530.00	990.00	1600.00	2210.00	2940.00
	4920.00								

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY WJV DATE 7-30-80 PROJ. NO. 79-203-042

CHKD. BY DJS DATE 7-30-80 SHEET NO. C OF O

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RESERVOIR OUTFLOW HYDROGRAPHS

SURFACE AREA=	0.	30.	32.	44.
CAPACITY=	0.	92.	132.	387.
ELEVATION=	1203.	1212.	1213.	1220.

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
1212.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1213.3	0.0	0.0	0.

0.05 PMF

PEAK OUTFLOW IS 64. AT TIME 43.83 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	64.	41.	13.	6.	1819.
CMS	2.	1.	0.	0.	51.
INCHES		.35	.43	.43	.43
MM		8.86	10.84	10.85	10.85
AC-FT		20.	25.	25.	25.
THOUS CU M		25.	31.	31.	31.

0.50 PMF

PEAK OUTFLOW IS 1478. AT TIME 41.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1478.	979.	294.	147.	42385.
CMS	42.	28.	8.	4.	1200.
INCHES		8.28	9.95	9.96	9.96
MM		210.28	252.87	252.90	252.90
AC-FT		485.	584.	584.	584.
THOUS CU M		599.	720.	720.	720.

PMF

PEAK OUTFLOW IS 2990. AT TIME 41.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2990.	1979.	609.	305.	87782.
CMS	85.	56.	17.	9.	2486.
INCHES		16.74	20.61	20.62	20.62
MM		425.10	523.61	523.76	523.76
AC-FT		981.	1209.	1209.	1209.
THOUS CU M		1210.	1491.	1491.	1491.

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY WJV DATE 7-30-80 PROJ. NO. 79-203-042

CHKD. BY DJJ DATE 7-30-80 SHEET NO. D OF O

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HYDROGRAPH ROUTING

ROUTE DAM OUTFLOWS THROUGH DOWNSTREAM ROADWAY EMBANKMENT/CULVERT

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OADWAY	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1201.	-1

STAGE	1201.10	1203.60	1206.10	1208.00	1210.00	1210.90	1211.40	1211.90	1212.40
	1213.40	1213.90	1214.40	1214.90	1215.40	1215.90			
FLOW	0.00	40.00	130.00	190.00	240.00	250.00	280.00	390.00	530.00
	1160.00	1660.00	2210.00	2800.00	3450.00	4630.00			

SURFACE AREA=	0.	0.	0.	1.
CAPACITY=	0.	0.	0.	1.
ELEVATION=	1201.	1203.	1211.	1216.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1201.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1210.9	0.0	0.0	0.

PEAK OUTFLOW IS 64. AT TIME 43.83 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	64.	41.	13.	6.	1818.
CMS	2.	1.	0.	0.	51.
INCHES		0.35	0.43	0.43	0.43
MM		8.86	10.84	10.85	10.85
AC-FT		20.	25.	25.	25.
THOUS CU M		25.	31.	31.	31.

0.05 PMF

DOWNSTREAM
ROADWAY
EMBANKMENT/
CULVERT
OUTFLOW
HYDROGRAPHS

PEAK OUTFLOW IS 1477. AT TIME 41.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1477.	979.	294.	147.	42380.
CMS	42.	28.	8.	4.	1200.
INCHES		8.28	9.95	9.96	9.96
MM		210.28	252.79	252.87	252.87
AC-FT		485.	584.	584.	584.
THOUS CU M		599.	720.	720.	720.

0.50 PMF

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY WJV DATE 7-30-80 PROJ. NO. 79-203-042

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ROADWAY EMBANKMENT OUTFLOW

PMF

PEAK OUTFLOW IS 2989. AT TIME 41.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2989.	1979.	609.	305.	87773.
CMS	85.	56.	17.	9.	2485.
INCHES		16.74	20.61	20.62	20.62
MM		425.11	523.56	523.71	523.71
AC-FT		981.	1209.	1209.	1209.
THOUS CU M		1211.	1491.	1491.	1491.

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HYDROGRAPH ROUTING

ROUTE FROM DAM/ROADWAY EMBANKMENT TO SECTION 2, 2970 FT D.S. FROM DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
102	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0700	.0450	.0700	1060.0	1080.0	2970.	.03500

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1080.00 140.00 1070.00 277.00 1063.00 280.00 1060.00 295.00 1060.00
305.00 1068.00 400.00 1069.50 630.00 1080.00

STORAGE	0.00	1.16	2.49	4.01	6.59	10.75	16.48	23.78	33.03
	67.10	89.25	114.13	141.71	172.01	205.02	240.74	279.17	320.32
OUTFLOW	0.00	101.08	324.26	652.53	1141.93	1863.60	2807.17	4272.33	6131.26
	12450.84	17219.75	23030.85	29943.15	38019.15	47321.96	57914.35	69858.29	83214.81
STAGE	1060.00	1061.05	1062.11	1063.16	1064.21	1065.26	1066.32	1067.37	1068.42
	1070.53	1071.58	1072.63	1073.68	1074.74	1075.79	1076.84	1077.89	1078.95
FLOW	0.00	101.08	324.26	652.53	1141.93	1863.60	2807.17	4272.33	6131.26
	12450.84	17219.75	23030.85	29943.15	38019.15	47321.96	57914.35	69858.29	83214.81

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY WJV DATE 7-30-80 PROJ. NO. 79-203-042

CHKD. BY DJS DATE 7-30-80 SHEET NO. F OF O

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**********          **********          **********          **********          **********

                                HYDROGRAPH ROUTING

              ROUTE FROM SECTION 2 TO SECTION 3, 9230 FT D.S. FROM DAM

                       ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                         203       1       0       0       0       0       1       0       0
                                              ROUTING DATA
                QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                  0.0   0.000    0.00       1       1       0       0               0

                       NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                           1       0       0   0.000   0.000   0.000     -1.       0

NORMAL DEPTH CHANNEL ROUTING
----------------------------

          QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
          .0700   .0450   .1000   900.0   920.0   6260.  .02400

          CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
             0.00  920.00  110.00  910.00  207.00  903.00  210.00  900.00  225.00  900.00
           228.00  903.00  260.00  910.00  300.00  920.00

STORAGE         0.00        2.43        5.18        8.27       13.35       21.37       32.33       46.21       63.04
              105.41      130.49      157.96      187.82      220.06      254.70      291.72      331.13      372.93

OUTFLOW         0.00       83.17      265.03      533.06      947.22     1537.76     2350.36     3424.02     4794.16
             8582.32    11075.04    13960.02    17256.68    20984.31    25161.98    29808.45    34942.24    40581.58

  STAGE       900.00      901.05      902.11      903.16      904.21      905.26      906.32      907.37      908.42
              910.53      911.58      912.63      913.68      914.74      915.79      916.84      917.89      918.95

   FLOW         0.00       83.17      265.03      533.06      947.22     1537.76     2350.36     3424.02     4794.16
             8582.32    11075.04    13960.02    17256.68    20984.31    25161.98    29808.45    34942.24    40581.58

**********          **********          **********          **********          **********

                                HYDROGRAPH ROUTING

              ROUTE FROM SECTION 3 TO SECTION 4, 17580 FT D.S. FROM DAM

                       ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                         304       1       0       0       0       0       1       0       0
                                              ROUTING DATA
                QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                  0.0   0.000    0.00       1       1       0       0               0

                       NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                           1       0       0   0.000   0.000   0.000     -1.       0
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SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY WJV DATE 7-30-80 PROJ. NO. 79-203-042

CHKD. BY DJJ DATE 7-30-80 SHEET NO. G OF O

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NORMAL DEPTH CHANNEL ROUTING
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        QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
        .0800   .0400   .0800   750.0   780.0   8350.  .01600

        CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
           0.00  780.00  400.00  760.00  545.00  756.00  545.00  750.00  563.00  750.00
         563.00  756.00  650.00  762.00  900.00  780.00

STORAGE      0.00       5.45      10.90      16.34      22.28      44.70      91.38     160.59     246.69
           467.58     602.32     753.26     920.39    1103.72    1303.24    1518.96    1750.87    1998.98

OUTFLOW      0.00     163.03     471.75     854.76    1303.72    2095.41    3600.74    6204.75   10014.48
         21605.52   29628.94   39298.89   50732.15   64042.26   79339.67   96732.06  116324.51  138219.74

  STAGE    750.00     751.58     753.16     754.74     756.32     757.89     759.47     761.05     762.63
           765.79     767.37     768.95     770.53     772.11     773.68     775.26     776.84     778.42

   FLOW      0.00     163.03     471.75     854.76    1303.72    2095.41    3600.74    6204.75   10014.48
         21605.52   29628.94   39298.89   50732.15   64042.26   79339.67   96732.06  116324.51  138219.74

    **********         **********         **********         **********         **********

                              HYDROGRAPH ROUTING

              ROUTE FROM SECTION 4 TO SECTION 5. 17880 FT D.S. FROM DAM

                     ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                       405       1       0       0       0       0       1       0       0
                                          ROUTING DATA
              QLOSS  CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                0.0  0.000    0.00       1       1       0       0               0

                     NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                         1       0       0   0.000   0.000   0.000     -1.       0

NORMAL DEPTH CHANNEL ROUTING
----------------------------

        QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
        .2000   .0400   .1000   745.5   770.0    300.  .01600

        CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
           0.00  780.00   20.00  760.00  700.00  752.50  700.00  745.50  707.00  745.50
         707.00  752.50  870.00  760.00 1100.00  770.00

STORAGE      0.00        .06        .12        .19        .25        .31        .58       2.02       4.75
            14.07      20.66      28.25      36.14      44.31      52.75      61.47      70.46      79.73

OUTFLOW      0.00      40.88     110.71     191.41     277.66     367.14     497.52     882.17    1748.23
```

SUBJECT DAM SAFETY INSPECTION

TOTEM LAKE DAM

BY WJV DATE 7-30-80 PROJ. NO. 79-203-042

CHKD. BY DJS DATE 7-30-80 SHEET NO. H OF O

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STAGE	745.50	746.79	748.08	749.37	750.66	751.95	753.24	754.53	755.82
	758.39	759.68	760.97	762.26	763.55	764.84	766.13	767.42	768.71
FLOW	0.00	40.88	110.71	191.41	277.66	367.14	497.52	882.17	1748.23
	5637.65	8966.85	13871.17	20048.65	27330.70	35716.16	45211.10	55826.13	67574.95

SUMMARY OF DAM SAFETY ANALYSIS

TOTEM LAKE DAM SUMMARY

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1212.00	1212.00	1213.30
STORAGE	92.	92.	132.
OUTFLOW	0.	0.	30.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	1213.39	.09	135.	64.	3.50	43.83	0.00
.50	1215.20	1.90	197.	1478.	10.67+	41.50	0.00
1.00	1216.33	3.03	238.	2990.	13.50+	41.50	0.00

OVERTOPPING OCCURS @ ≈ 0.02 PMF

ROADWAY EMBANKMENT/ CULVERT SUMMARY

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1201.10	1201.10	1210.90
STORAGE	0.	0.	0.
OUTFLOW	0.	0.	250.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	1204.27	0.00	0.	64.	0.00	43.83	0.00
.50	1213.72	2.82	0.	1477.	7.83	41.50	0.00
1.00	1215.05	4.15	1.	2989.	10.33	41.50	0.00

SUBJECT: DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY: WJV DATE: 7-30-80 PROJ. NO. 79-203-042

CHKD. BY: DJS DATE: 7-30-80 SHEET NO. I OF O

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SECTION 2 — @ 2970 FT DS FROM DAM

STATION 102

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.05	64.	1060.7	44.00
.50	1476.	1064.7	41.67
1.00	2978.	1066.4	41.67

SECTION 3 — @ 9230 FT DS FROM DAM

STATION 203

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.05	61.	900.8	44.50
.50	1465.	905.1	41.83
1.00	2955.	906.9	41.67

SECTION 4 — @ 17580 FT DS FROM DAM

STATION 304

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.05	59.	750.6	44.83
.50	1434.	756.6	42.17
1.00	2859.	758.7	42.17

SECTION 5 — @ 17880 FT DS FROM DAM

STATION 405

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.05	59.	747.1	44.83
.50	1434.	755.3	42.17
1.00	2859.	756.8	42.17

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY WJV DATE 7-30-80 PROJ. NO. 79-203-042

CHKD. BY DJS DATE 7-30-80 SHEET NO. J OF ○

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BREACHING ANALYSIS

(INPUT SAME AS THAT FOR OVERTOPPING ANALYSIS, WITH THE ADDITION OF BREACH CRITERIA GIVEN HERE, AND DELETION OF THE ROADWAY EMBANKMENT ROUTING DATA.)

```
DAM SAFETY INSPECTION
TOTEM LAKE DAM AND DOWNSTREAM ROADWAY EMBANKMENT: BREACHING ANALYSIS
15-MINUTE TIME STEP AND 48-HOUR STORM DURATION

                                  JOB SPECIFICATION
    NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
   288        0       10        0        0        0        0        0        0        0
                            JOPER      NWT    LROPT    TRACE
                                5        0        0        0

                       MULTI-PLAN ANALYSES TO BE PERFORMED
                         NPLAN= 2 NRTIO= 1 LRTIO= 1
      RTIOS=    .15

*********          *********          *********          *********          *********

                                HYDROGRAPH ROUTING

   ROUTE THROUGH RESERVOIR

                                                  DAM DATA
                                       TOPEL     COQD     EXPD    DAMWID
                                      1213.3      0.0      0.0        0.

PLAN 1                                           DAM BREACH DATA
                               BRWID        Z     ELBM    TFAIL     WSEL   FAILEL
                                 17.     1.00  1203.20      .50  1212.00  1213.80

                                        STATION DAM    , PLAN 1, RATIO 1

BEGIN DAM FAILURE AT 40.83 HOURS     PEAK OUTFLOW IS      2353. AT TIME   41.33 HOURS

PLAN 2                                           DAM BREACH DATA
                               BRWID        Z     ELBM    TFAIL     WSEL   FAILEL
                                 17.     1.00  1203.20     4.00  1212.00  1213.80

                                        STATION DAM    , PLAN 2, RATIO 1

BEGIN DAM FAILURE AT 40.83 HOURS
                                     PEAK OUTFLOW IS       941. AT TIME   44.00 HOURS
```

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY WJV DATE 7-30-80 PROJ. NO. 79-203-042

CHKD. BY DJS DATE 7-30-80 SHEET NO. K OF O

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THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .010 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .167 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	-	COMPUTED BREACH HYDROGRAPH (CFS)	=	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
40.833	0.000	245.		245.		0.	0.	0.
40.843	.010	272.		281.		-9.	-9.	-0.
40.853	.020	300.		299.		1.	-8.	-0.
40.863	.029	328.		319.		9.	1.	0.
40.873	.039	355.		340.		16.	17.	0.
40.882	.049	383.		362.		21.	38.	0.
40.892	.059	411.		386.		25.	63.	0.
40.902	.069	439.		411.		28.	91.	0.
40.912	.078	466.		437.		30.	121.	0.
40.922	.088	494.		464.		30.	151.	0.
40.931	.098	522.		492.		29.	181.	0.
40.941	.108	549.		522.		28.	208.	0.
40.951	.118	577.		552.		25.	234.	0.
40.961	.127	605.		583.		22.	256.	0.
40.971	.137	633.		615.		18.	273.	0.
40.980	.147	660.		648.		13.	286.	0.
40.990	.157	688.		681.		7.	293.	0.
41.000	.167	716.		716.		-0.	293.	0.
41.010	.176	758.		751.		7.	299.	0.
41.020	.186	799.		786.		13.	312.	0.
41.029	.196	841.		823.		19.	331.	0.
41.039	.206	883.		860.		23.	354.	0.
41.049	.216	925.		900.		25.	379.	0.
41.059	.225	967.		941.		26.	405.	0.
41.069	.235	1009.		982.		27.	432.	0.
41.078	.245	1051.		1024.		26.	459.	0.
41.088	.255	1093.		1067.		26.	484.	0.
41.098	.265	1135.		1110.		24.	508.	0.
41.108	.275	1177.		1154.		22.	531.	0.
41.118	.284	1218.		1199.		20.	550.	0.
41.127	.294	1260.		1244.		17.	567.	0.
41.137	.304	1302.		1289.		13.	580.	0.
41.147	.314	1344.		1335.		9.	589.	0.
41.157	.324	1386.		1381.		5.	594.	0.
41.167	.333	1428.		1428.		0.	594.	0.
41.176	.343	1482.		1475.		7.	601.	0.
41.186	.353	1537.		1522.		14.	616.	0.
41.196	.363	1591.		1570.		21.	637.	1.
41.206	.373	1646.		1618.		28.	665.	1.
41.216	.382	1700.		1666.		34.	699.	1.
41.225	.392	1754.		1714.		40.	739.	1.
41.235	.402	1809.		1763.		46.	785.	1.
41.245	.412	1863.		1812.		52.	837.	1.
41.255	.422	1918.		1860.		57.	894.	1.
41.265	.431	1972.		1916.		56.	950.	1.
41.275	.441	2027.		1977.		49.	999.	1.
41.284	.451	2081.		2039.		42.	1041.	1.
41.294	.461	2135.		2102.		34.	1075.	1.
41.304	.471	2190.		2164.		26.	1100.	1.
41.314	.480	2244.		2227.		17.	1118.	1.
41.324	.490	2299.		2290.		9.	1127.	1.
[illegible]	[illegible]	[illegible]		[illegible]		-0.	1127.	1.

PLAN
1

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY WJV DATE 7-30-80 PROJ. NO. 79-203-042

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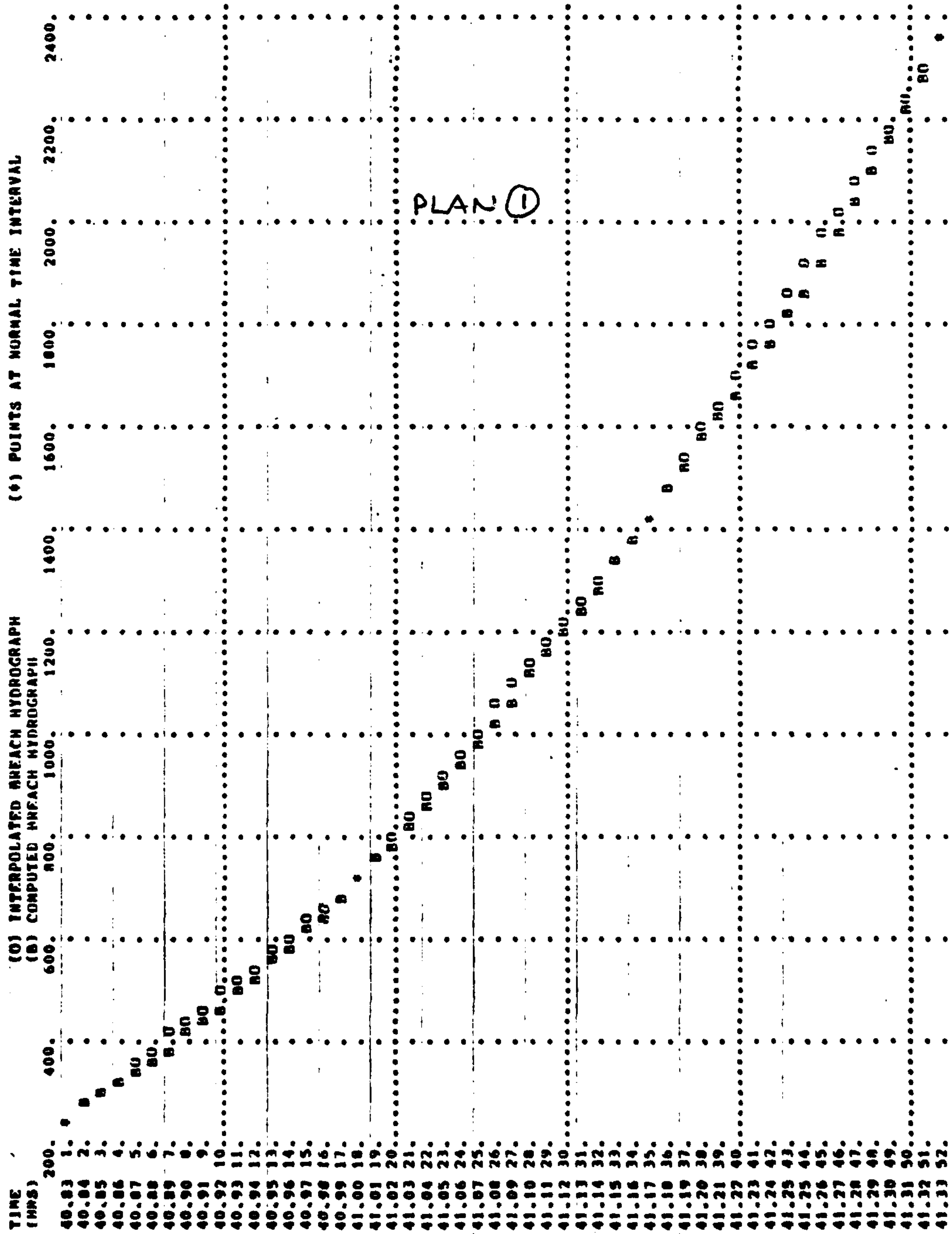

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY WJV DATE 7-30-80 PROJ. NO. 79-203-042

CHKD. BY DJS DATE 7-30-80 SHEET NO. M OF O

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THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .083 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .167 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

PLAN 2

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	-	COMPUTED BREACH HYDROGRAPH (CFS)	=	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
40.833	0.000	245.		245.		0.	0.	0.
40.917	.083	292.		303.		-12.	-12.	-0.
41.000	.167	339.		339.		-0.	-12.	-0.
41.083	.250	371.		372.		-1.	-13.	-0.
41.167	.333	404.		404.		0.	-13.	-0.
41.250	.417	432.		434.		-1.	-14.	-0.
41.333	.500	461.		461.		0.	-14.	-0.
41.417	.583	484.		485.		-1.	-15.	-0.
41.500	.667	507.		507.		0.	-15.	-0.
41.583	.750	525.		526.		-1.	-17.	-0.
41.667	.833	543.		543.		-0.	-17.	-0.
41.750	.917	556.		557.		-1.	-18.	-0.
41.833	1.000	569.		569.		0.	-18.	-0.
41.917	1.083	581.		579.		2.	-15.	-0.
42.000	1.167	593.		593.		0.	-15.	-0.
42.083	1.250	608.		609.		-1.	-16.	-0.
42.167	1.333	622.		622.		0.	-16.	-0.
42.250	1.417	634.		635.		-1.	-17.	-0.
42.333	1.500	645.		645.		0.	-17.	-0.
42.417	1.583	654.		654.		-1.	-18.	-0.
42.500	1.667	662.		662.		0.	-18.	-0.
42.583	1.750	668.		669.		-1.	-18.	-0.
42.667	1.833	674.		674.		0.	-18.	-0.
42.750	1.917	700.		697.		2.	-16.	-0.
42.833	2.000	725.		725.		0.	-16.	-0.
42.917	2.083	750.		751.		-1.	-17.	-0.
43.000	2.167	775.		775.		0.	-17.	-0.
43.083	2.250	798.		799.		-1.	-18.	-0.
43.167	2.333	821.		821.		0.	-18.	-0.
43.250	2.417	840.		841.		-1.	-19.	-0.
43.333	2.500	859.		859.		0.	-19.	-0.
43.417	2.583	875.		876.		-1.	-20.	-0.
43.500	2.667	890.		890.		0.	-20.	-0.
43.583	2.750	903.		903.		-0.	-20.	-0.
43.667	2.833	916.		916.		0.	-20.	-0.
43.750	2.917	925.		927.		-2.	-21.	-0.
43.833	3.000	935.		935.		0.	-21.	-0.
43.917	3.083	938.		939.		-2.	-23.	-0.
44.000	3.167	941.		941.		0.	-23.	-0.
44.083	3.250	936.		938.		-2.	-25.	-0.
44.167	3.333	932.		932.		0.	-25.	-0.
44.250	3.417	920.		922.		-2.	-27.	-0.
44.333	3.500	907.		907.		0.	-27.	-0.
44.417	3.583	886.		889.		-2.	-29.	-0.
44.500	3.667	865.		865.		0.	-29.	-0.
44.583	3.750	835.		837.		-3.	-32.	-0.
44.667	3.833	804.		804.		0.	-32.	-0.
44.750	3.917	762.		765.		-3.	-35.	-0.
44.833	4.000	720.		720.		0.	-35.	-0.

SUBJECT DAM SAFETY INSPECTION
TOTEM LAKE DAM

BY WJV DATE 7-30-80 PROJ. NO. 79-203-042

CHKD. BY DJS DATE 7-30-80 SHEET NO. N OF O

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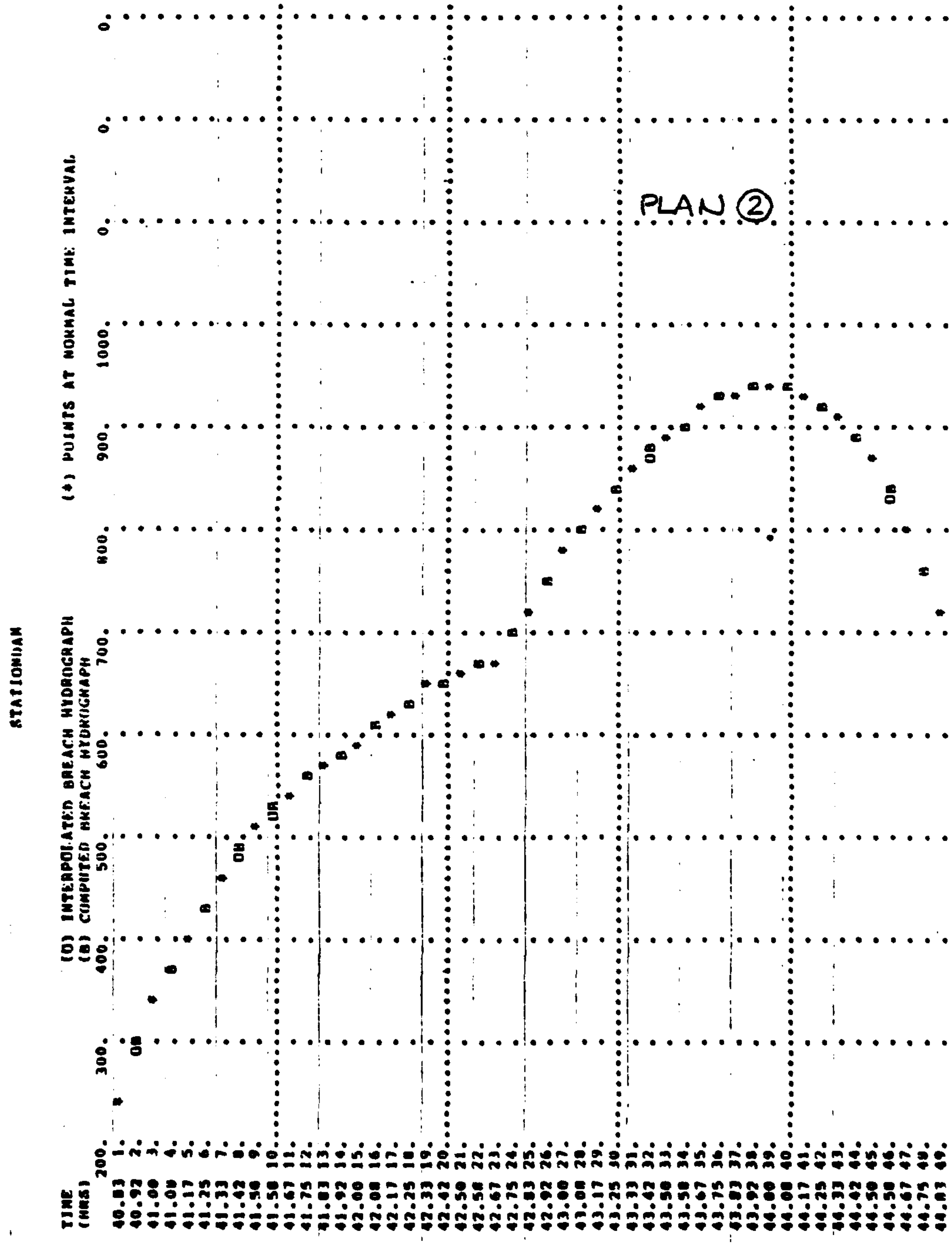

SUBJECT DAM SAFETY INSPECTION

TOTEM LAKE DAM

BY WJV DATE 7-30-80 PROJ. NO. 79-203-042

CHKD. BY DJS DATE 7-30-80 SHEET NO. O OF O

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SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1212.00	1212.00	1213.30
STORAGE	92.	92.	132.
OUTFLOW	0.	0.	30.

TOTEM LAKE DAM SUMMARY

PLAN	RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1	.15	1213.86	.56	151.	2353.	1.42	41.33	40.83
2	.15	1213.95	.65	154.	941.	2.83	44.00	40.83

STATION 102

SECTION 2 @ 2970 FT DS

PLAN	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1	.15	2209.	1065.8	41.50
2	.15	939.	1063.8	44.00

STATION 203

SECTION 3 @ 9230 FT DS

PLAN	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1	.15	1961.	905.8	41.67
2	.15	934.	904.2	44.17

STATION 304

SECTION 4 @ 17580 FT DS

PLAN	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1	.15	1682.	757.1	42.00
2	.15	928.	755.0	44.33

STATION 405

SECTION 5 @ 17890 FT DS

PLAN	RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1	.15	1692.	755.7	42.00
2	.15	928.	754.6	44.33

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AD-A091 488 GAI CONSULTANTS INC MONROEVILLE PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. TOTEM DAM (NDI I.D. NUMBER PA---ETC(U)
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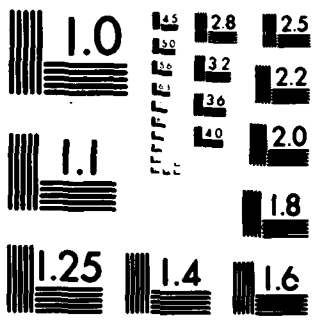


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

APPENDIX E

FIGURES

LIST OF FIGURES

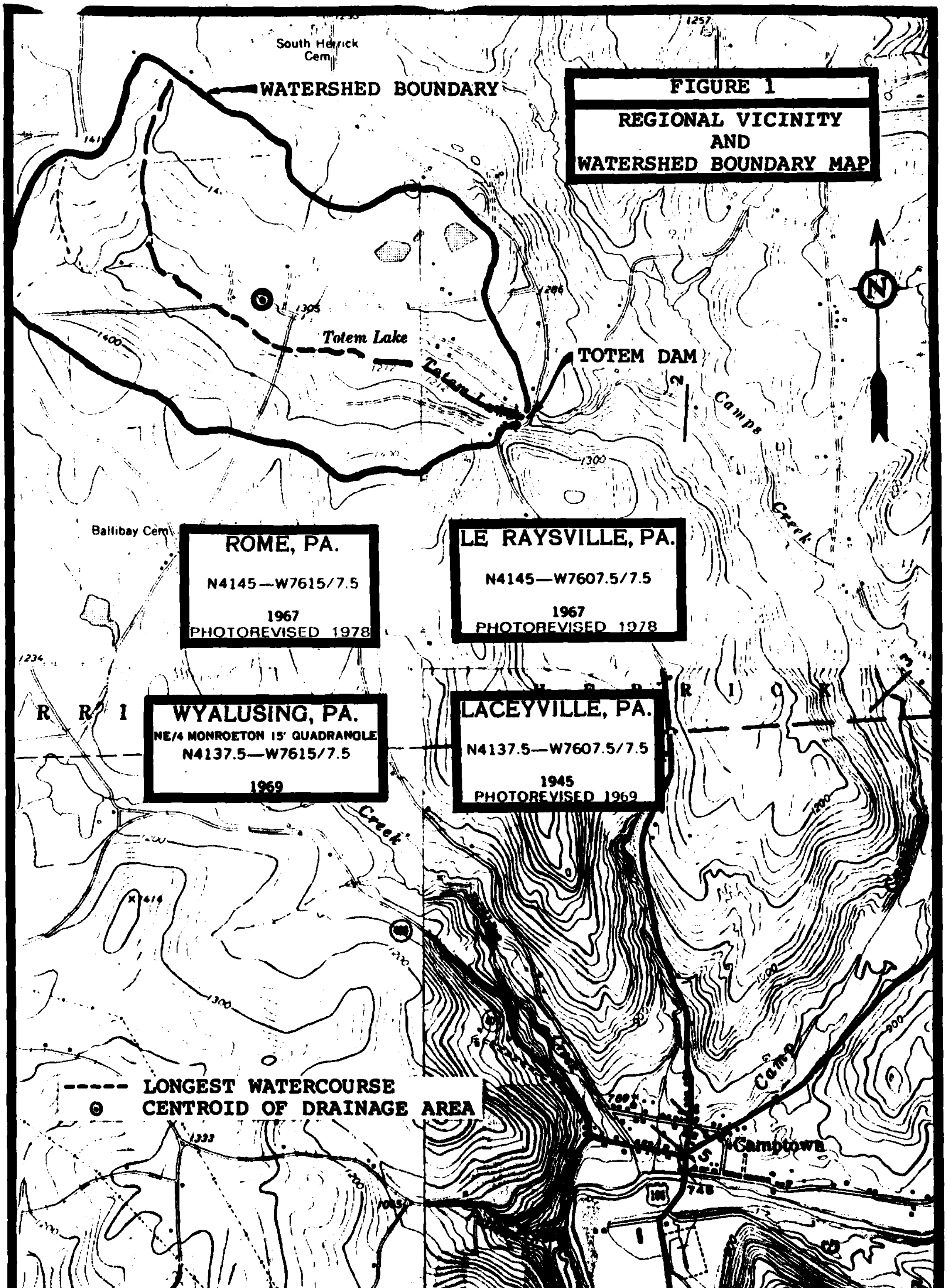
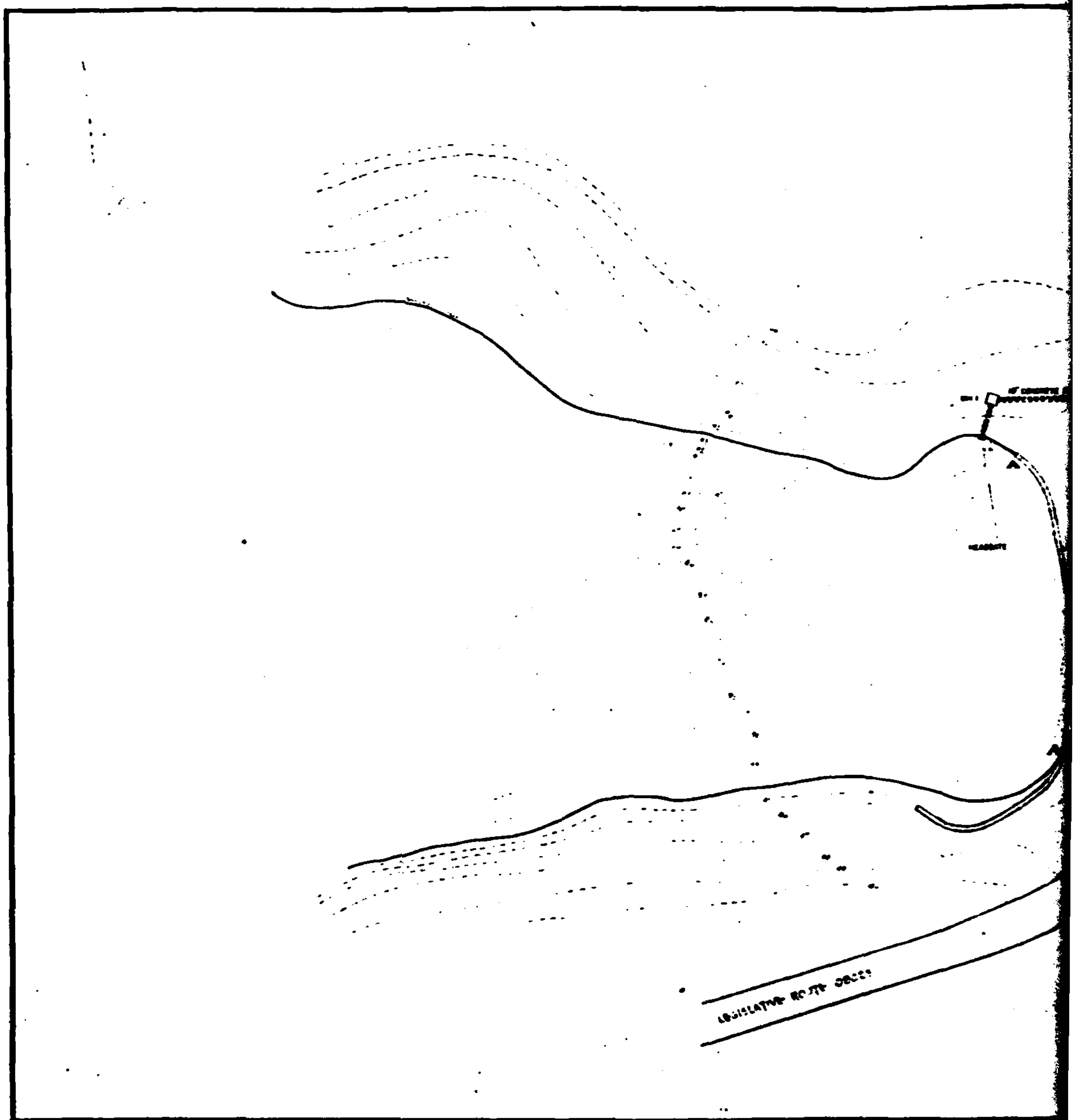


FIGURE 1
REGIONAL VICINITY
AND
WATERSHED BOUNDARY MAP
WATERSHED BOUNDARY
South Herrick Cem
Totem Lake
TOTEM DAM
Camps Creek
Ballibay Cem
ROME, PA.
N4145—W7615/7.5
1967
PHOTOREVISED 1978
LE RAYSVILLE, PA.
N4145—W7607.5/7.5
1967
PHOTOREVISED 1978
WYALUSING, PA.
NE/4 MONROETON 15' QUADRANGLE
N4137.5—W7615/7.5
1969
LACEYVILLE, PA.
N4137.5—W7607.5/7.5
1945
PHOTOREVISED 1969
Camptown
LONGEST WATERCOURSE
CENTROID OF DRAINAGE AREA



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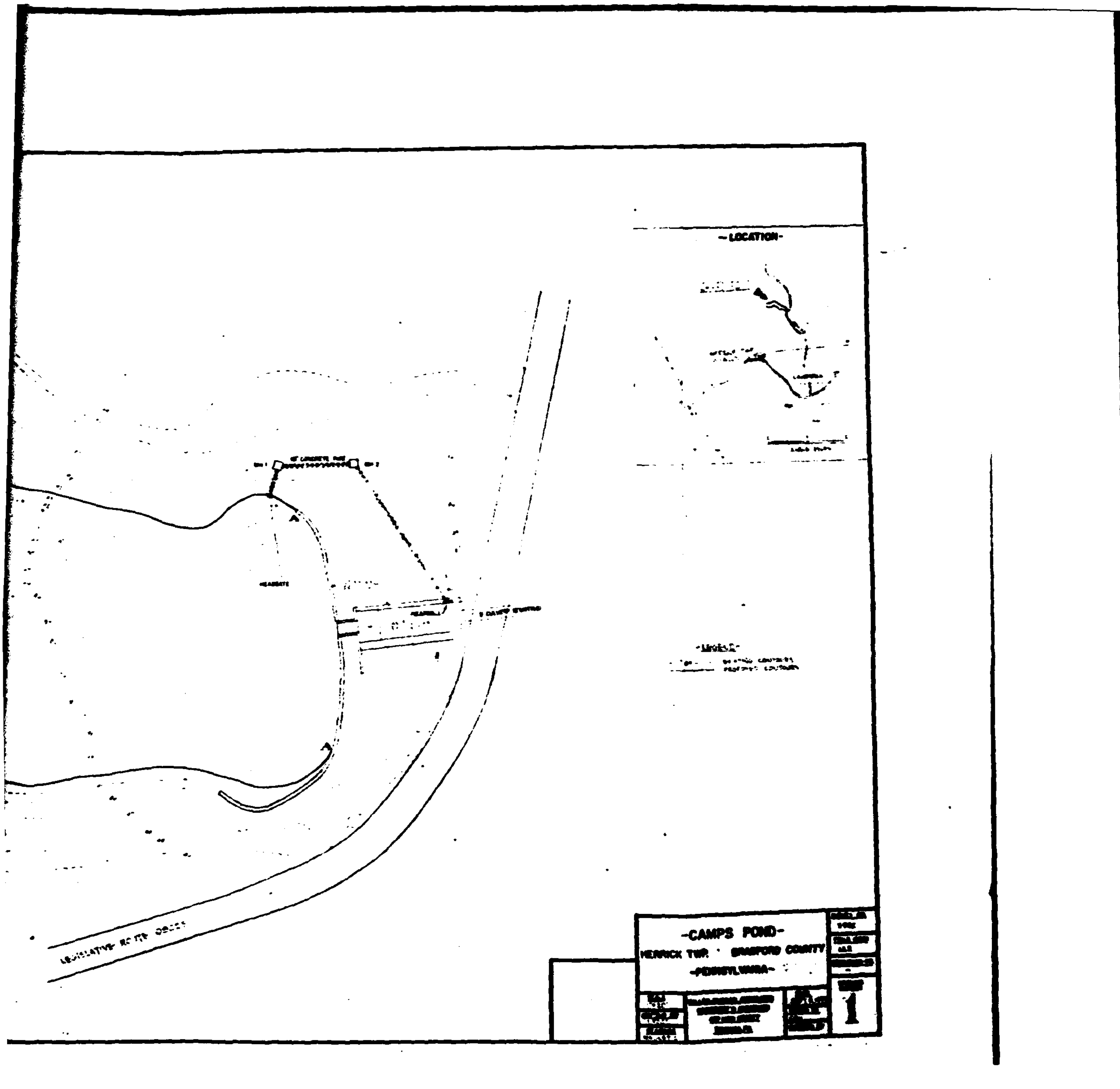

2

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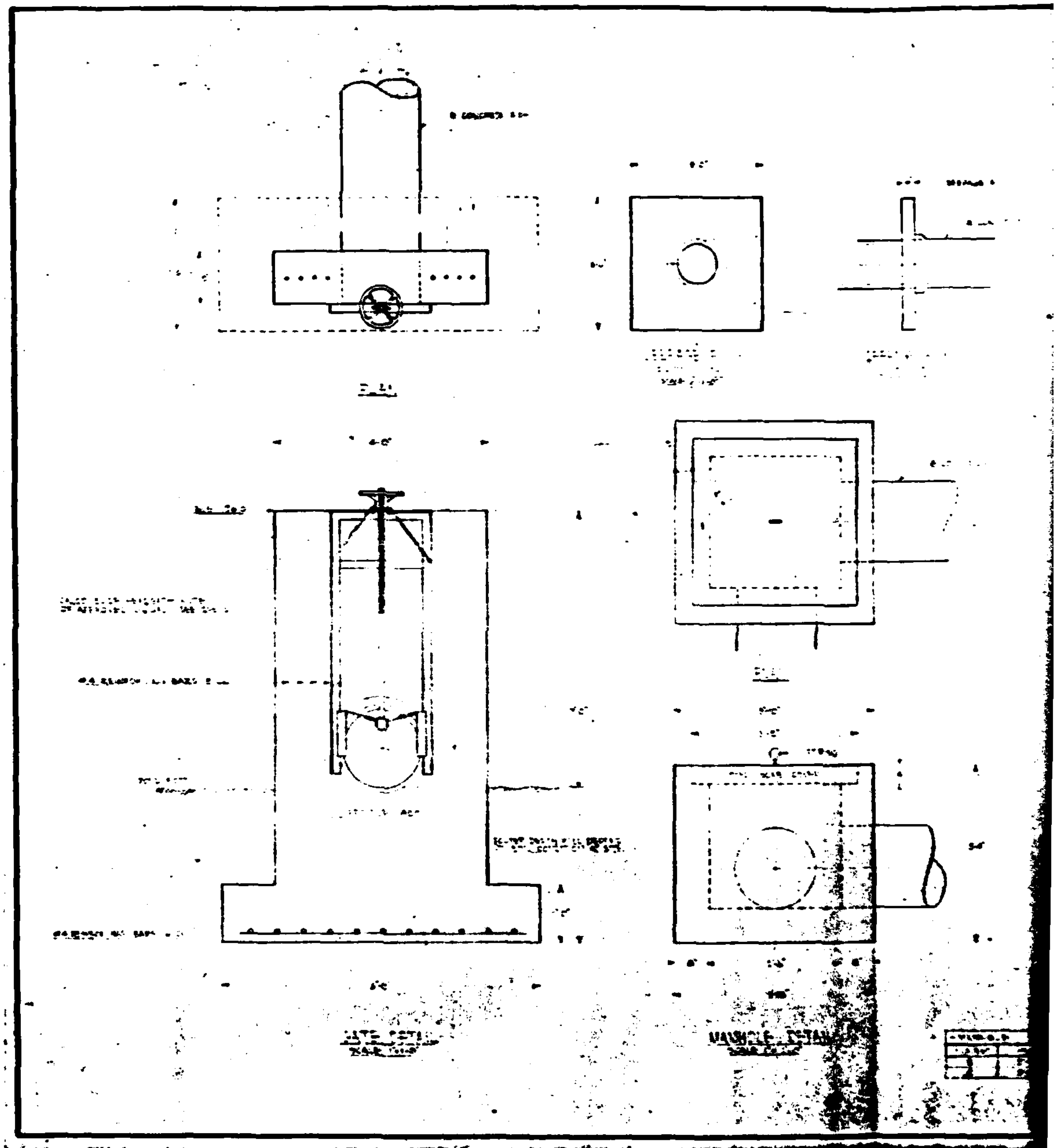
FIGURE 2



MANHOLE DETAIL

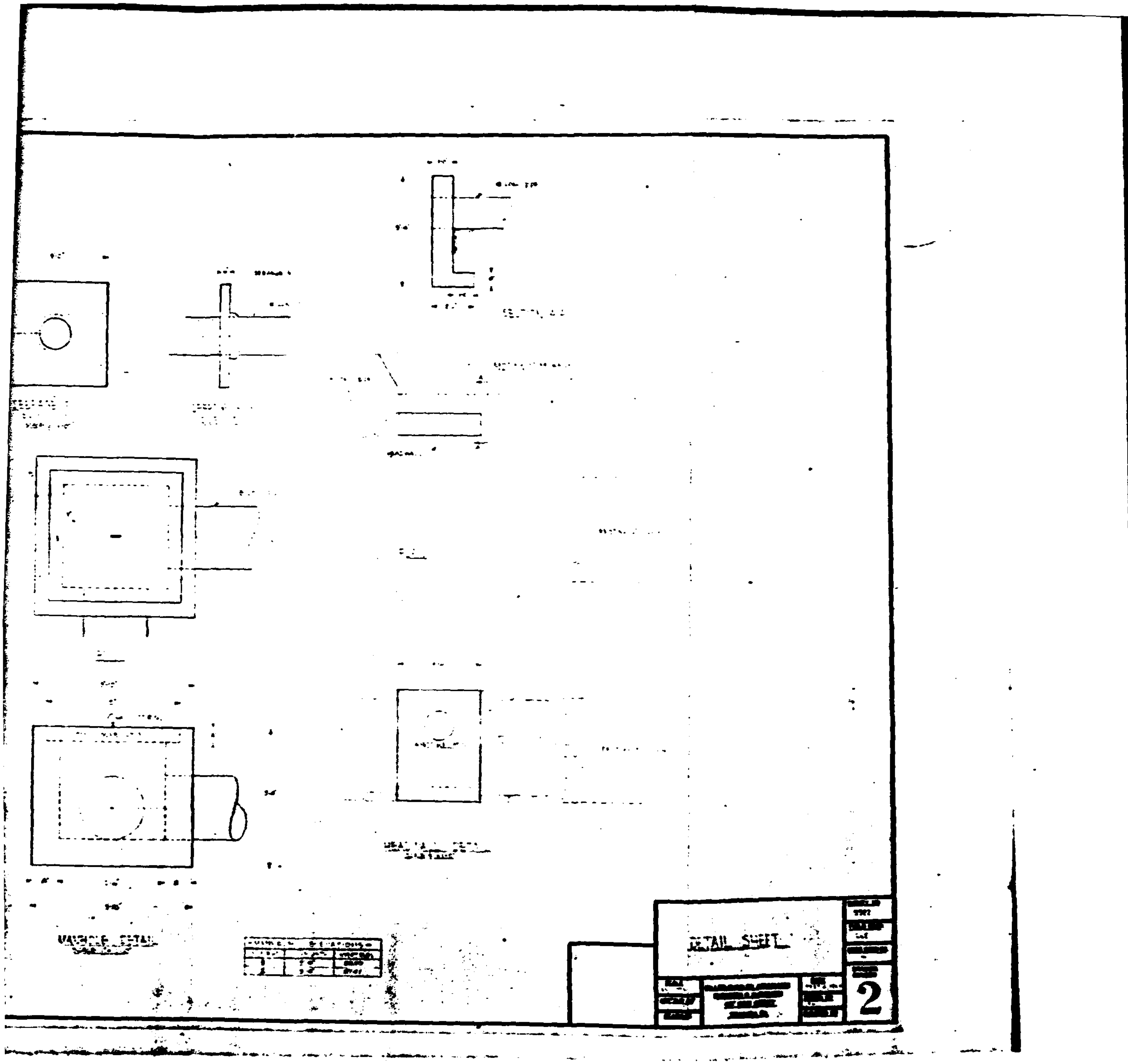


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FIGURE 3

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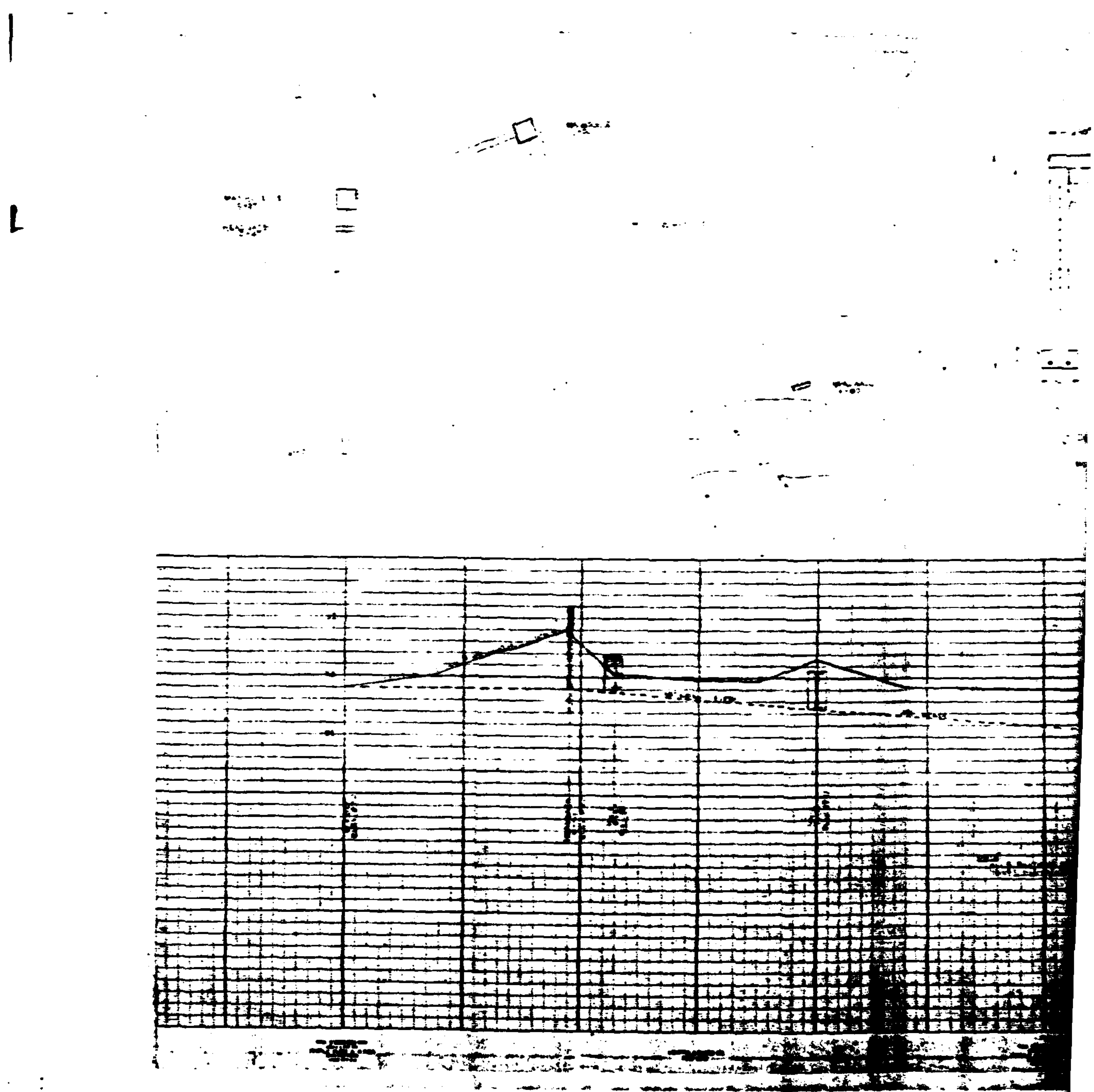

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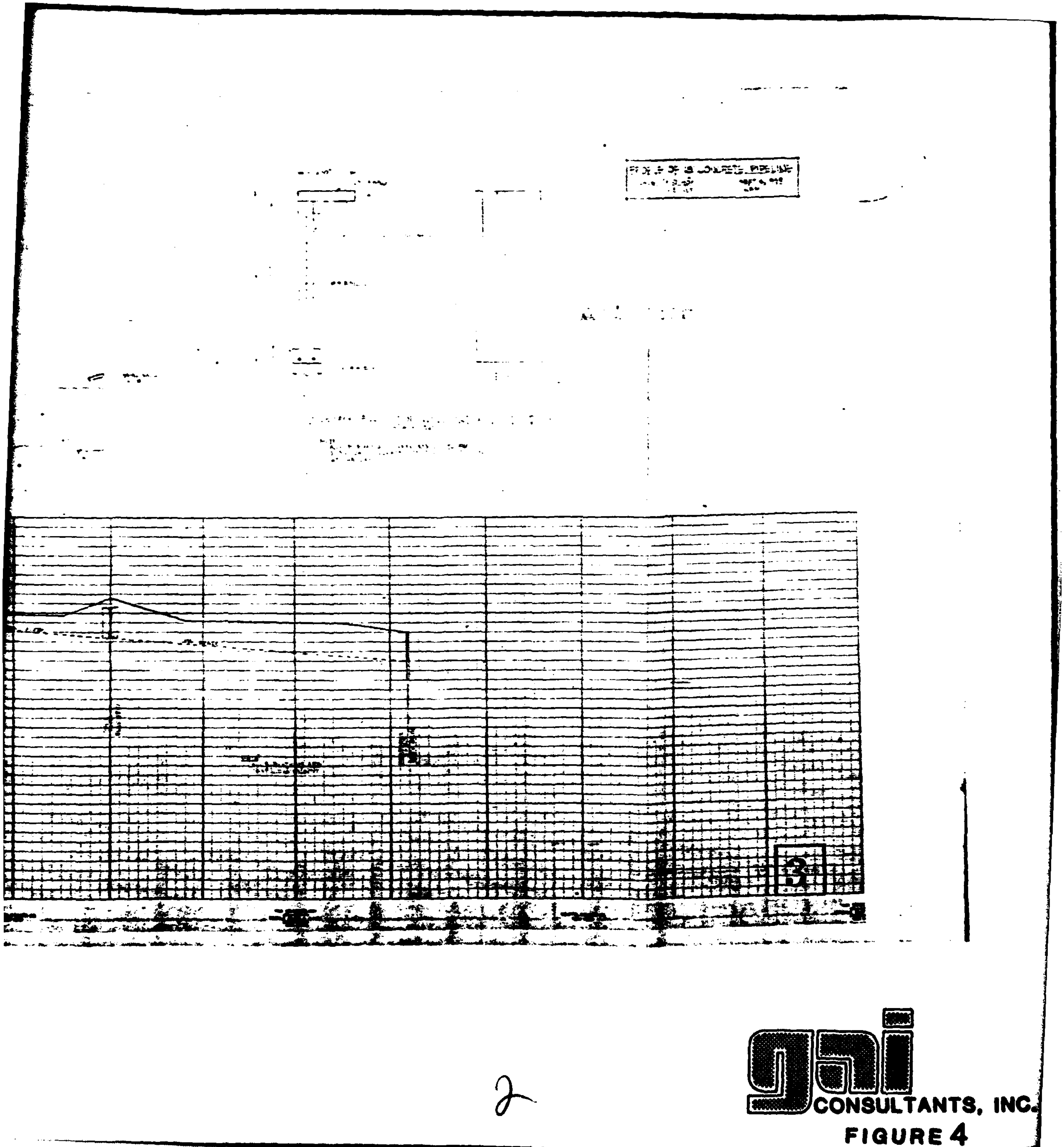

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FIGURE 4

APPENDIX F

GEOLOGY

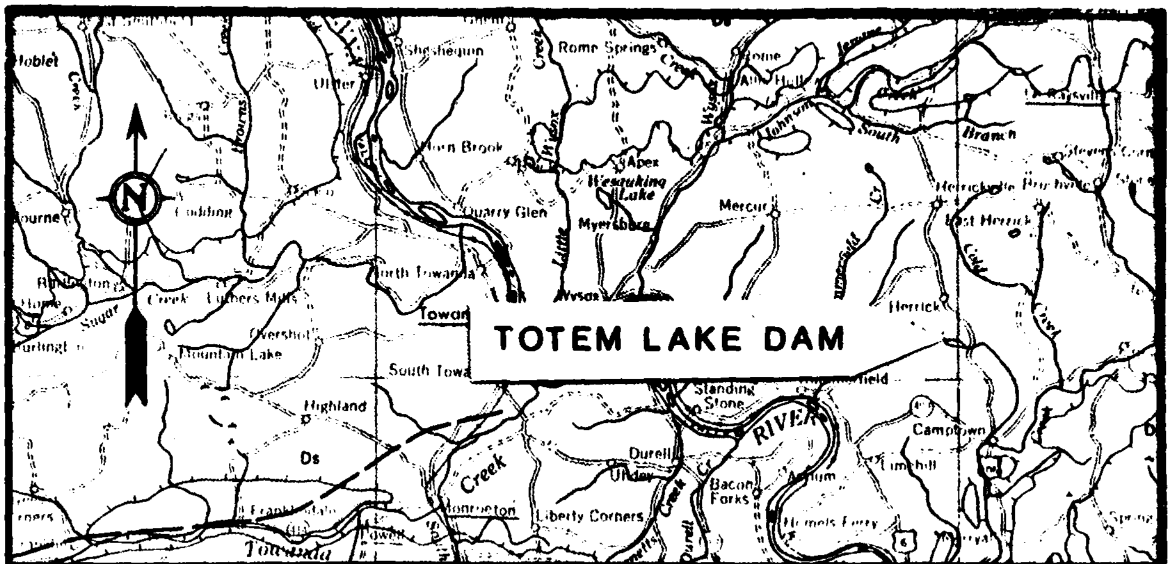
Geology

Totem Lake Dam is located approximately 3.0 miles northwest of Camptown within the eastern third of Bradford County. Geographically, the site is situated within the glaciated portion of the Low Plateaus section of the Appalachian Plateaus province. The area surrounding the dam and watershed is blanketed with a veneer of glacial soil deposited during the most recent period of continental glaciation. Glacial drift generally consists of clayey or silty soils with cobbles and boulders. Overlying the glacial deposits are recent alluvial deposits and small deposits of water-laid drift which mantle the slopes, ridgetops, and many valley bottoms. Exposed thickness of till ranges from a few to about 40 feet with maximum inferred thickness of more than 100 feet. Exposed thickness of colluvium ranges from a few to 15 feet.

Bedrock underlying the dam and reservoir consists of predominantly shale, sandstone, and a few thin beds of impure limestone of the Chemung formation of Upper Devonian age. The sandstone is in part calcareous and fossiliferous.

Structurally, the site lies just south of the axial trace of the Le Raysville anticline, a gentle fold striking in a southwest-northeast direction with little surface expression in the vicinity of the site. Bedrock, therefore, dips gently to the southeast.

Denney, Charles S., Surficial Geology and Soils of the Elmira-Williamsport Region, New York and Pennsylvania: United States Geological Survey Professional Paper 379 - Washington D. C., 1963.



LEGEND

DEVONIAN

Oswayo Formation
Brownish and greenish gray, fine and medium grained sandstones with some shales and scattered calcareous lenses; includes red shales which become more numerous eastward. Relation to type Oswayo not proved.

Dck

Catskill Formation
Chiefly red to brownish shales and sandstones; includes gray and greenish sandstone tongues named Elk Mountain, Honesdale, Shohola, and Delaware River to the east.

Dm

Marine beds
Gray to olive brown shales, graywackes, and sandstones, contains "Chemung" beds and "Portage" beds including Burket, Brallier, Harrell, and Trimmers Rock; Tully Limestone at base.

Ds

Susquehanna Group

barbed line is "Chemung-Catskill" contact of Second Pennsylvania Survey County reports; barbs on "Chemung" side of line.

Note: The bedrock surface is covered with Pleistocene age Wisconsin and Illinoian till composed of sands, gravels and silty clays of variable thicknesses.

Scale

0 2 4 6 8 10 MILES

REFERENCE:
GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA. DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

GEOLOGY MAP

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